

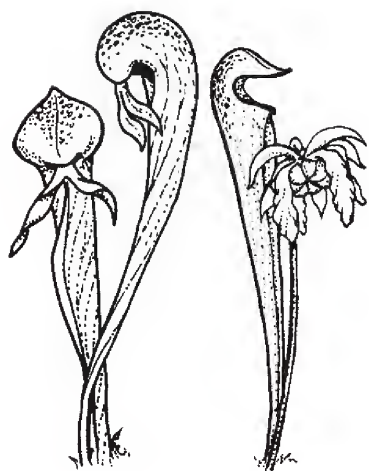
CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society

Volume 45, No. 2

June 2016





CARNIVOROUS PLANT NEWSLETTER

Journal of the International
Carnivorous Plant Society
www.carnivorousplants.org

Volume 45, Number 2
June 2016



Front Cover: *Pinguicula ramosa* at Mt. Nantai-san, Japan. Photo by Hiro Shimai. Article on page 51.

Back Cover: *Sarracenia* 'Ares' mature plant. Photo by Jerry Addington. Article on page 73.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

All correspondence regarding dues, address changes and missing issues should be sent to the Membership Coordinator at the ICPS. Do not send such correspondence to the editors. Checks for subscriptions should be made to the International Carnivorous Plant Society in US funds. Dues, including a subscription, are \$30 per year.

International Carnivorous Plant Society, Inc.
2121 N. California Blvd., Suite 290
Walnut Creek, CA 94596-7351, USA
icps@carnivorousplants.org

President
Vice President
Secretary
Treasurer
Board Member
Board Member
Board Member
Membership Coordinator
Webmaster
Seed Bank Manager
CPN Editors
Managing Editor
Editor
Editor
Editor
Science Editor
Science Editor

Marcel van den Broek, marcel@carnivorousplants.org
Richard Nunn, richardnunn@carnivorousplants.org
Keith Becker, keith@carnivorousplants.org
Ryan Ward, ryan@carnivorousplants.org
Greg Bourke, Conservation Director, greg@carnivorousplants.org
Jan Schlauer, Cultivar Registrar, jan@carnivorousplants.org
Bob Ziemer, bob@carnivorousplants.org
Sheila Stewart, sheila@carnivorousplants.org
John Brittnacher, john@carnivorousplants.org
Joe Griffin, joe@carnivorousplants.org
editor@carnivorousplants.org
Bob Ziemer
Barry Rice
Djoni Crawford
John Brittnacher
Fernando Rivadavia
Jan Schlauer

Date of effective publication of the March 2016 issue of Carnivorous Plant Newsletter: 19 February 2016.

The ICPS is the International Cultivar Registration Authority (ICRA) for the names of cultivated carnivorous plants according to the International Code of Nomenclature for Cultivated Plants. Send relevant correspondence to the ICPS, Inc.

Carnivorous Plant Newsletter is published quarterly in March, June, September, and December by the ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Periodicals postage paid at Walnut Creek, CA and additional mailing offices. Postmaster: Send address changes to ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Printed by Allen Press, Inc., 810 E. 10th Street, Lawrence, KS 66044. Logo and masthead art: Paul Milauskas. © 2016 International Carnivorous Plant Society. All rights reserved. ISSN #0190-9215

CONTENTS

A preliminary survey of the taxonomic composition of contents of <i>Nepenthes smilesii</i> Hemsl. pitchers in Bi Doup – Nui Ba National Park (South Vietnam) -----	40
<i>Pinguicula ramosa</i> Miyoshi – a botanical review -----	51
Water propagation of the Venus flytrap -----	69
Propagating <i>Drosophyllum</i> from cuttings -----	72
New cultivars -----	73

THE ICPS SEED BANK

an exclusive member benefit

The International Carnivorous Plant Society offers its members exclusive access to a variety of carnivorous plant seeds. Seeds are ordered online at the ICPS Store:

<http://icps.clubexpress.com>

The Seed Bank cannot exist without seed donations. Information about growing carnivorous plants from seed and donating seeds to the Seed Bank are at the ICPS public web site:

<http://www.carnivorousplants.org>

If you do not have access to the Internet, please send seed order form requests to:

International Carnivorous Plant Society, Inc.
2121 N. California Blvd., Suite 290
Walnut Creek, CA 94596-7351, USA

JOE GRIFFIN, Seed Bank Manager, joe@carnivorousplants.org

Carnivorous Plant Nursery

*Promoting environmental stewardship through
engaging educational materials and low-cost, high-quality carnivorous plants.*



- Carnivorous Plants
- Bog Orchids, Bog Plants
- Live Wingless Fruitflies
- Activity Book for Carnivorous Plants
- Bugs in the Bog Board Game
- Free Monthly Drawing
- Online Shopping and Mail Order

www.carnivorousplantnursery.com

301-824-0133 | info@carnivorousplantnursery.com | 13763 John Cline Road, Smithsburg, MD 21783

A PRELIMINARY SURVEY OF THE TAXONOMIC COMPOSITION OF CONTENTS
OF *NEPENTHES SMILESII* HEMSL. PITCHERS IN
BI DOUP – NUI BA NATIONAL PARK (SOUTH VIETNAM)

ANNA N. DEMIDOVA • Biological Faculty of M.V. Lomonosov Moscow State University (Moscow, Russia) • and • Russian-Vietnamese Tropical Research and Technology Center (Ho Chi Minh, Vietnam) • DEMIDOVA_A@rambler.ru

GREGORY S. EREMKin • Biological Faculty of M.V. Lomonosov Moscow State University (Moscow, Russia) • and • Moscow Society of Naturalists (Moscow, Russia)

EVGENY O. SHCHERBAKOV • Biological Faculty of M.V. Lomonosov Moscow State University (Moscow, Russia)

VLADIMIR A. ZRYANIN • Lobachevsky State University of Nizhny Novgorod (Nizhny Novgorod, Russia)

NIKOLAY G. PRILEPSKY • Biological Faculty of M.V. Lomonosov Moscow State University (Moscow, Russia) • and • Russian-Vietnamese Tropical Research and Technology Center (Ho Chi Minh, Vietnam)

Keywords: *Nepenthes smilesii*, Nepenthaceae, South Vietnam, pitchers, prey composition, invertebrates, ants, *Technomyrmex*.

Abstract: We present a taxonomic analysis of contents of *Nepenthes smilesii* Hemsley, 1895 (Nepenthaceae) pitchers collected in Bi Doup – Nui Ba National Park (South Vietnam). 230 specimens of insects, belonging to 7 orders and 17 families, as well as 7 specimens of arachnids (2 orders), 2 specimens of chilopods, 2 specimens of isopods and 1 specimen of oligochaetes were identified. Animal composition from *N. smilesii* pitchers is dominated by flightless and poorly flying invertebrate forms. Small ant species *Technomyrmex yamanei* Bolton, 2007 is a predominant prey. Besides ants, Heteroptera and Blattodea are groups dominating in ration, that distinguishes *N. smilesii* from other *Nepenthes* species, studied before in this context.

Introduction

The genus *Nepenthes* L. (Nepenthaceae) includes about 138 tropical species of carnivorous plants commonly known as pitcher plants (McPherson 2011). Unlike some other carnivorous plants (e.g., Droseraceae), their modified leaves (pitchers) are thought to represent a passive type of traps. The pitchers act as pitfalls: they contain a fluid of the plant's own production, which is used to drown the prey (Lloyd 1942). Despite the passive nature of the traps themselves, the prey spectrum of various *Nepenthes* species is far from random, as the plants apply very different trap strategies (e.g., Bonhomme *et al.* 2011; Moran *et al.* 2012; Chin *et al.* 2014).

The first studies of the diversity of *Nepenthes* prey were attempted as far as the beginning of 20th century (Jensen 1910). It was not until 1991, however, that the first quantitative study on *Nepenthes* prey items was published (Jebb 1991, cited after: Moran 1996). Since then a number of thematic studies were published (for example, Kato *et al.* 1993; Moran 1996; Adam 1997; Giusto *et al.* 2008; Rembold *et al.* 2010; Hosoishi *et al.* 2012). Most were dealing with the Malesian species of *Nepenthes*.

In this work we present a first quantitative study of the prey spectrum of a *Nepenthes* species from the *N. thorelii* complex, *N. smilesii* (Mey *et al.* 2010; F. Mey, pers. comm.).

Studies were conducted in the vicinity of Giang Ly forest station located in the south-east part of Bi Doup – Nui Ba National Park, Lam Dong province, South Vietnam. Tropical mid-mountain polydominant forests and mossy forests are predominant vegetation type here. In the locality under study *Nepenthes smilesii* is rare and was found as one population with a small number of individuals (<10 on the area 5×5 m). *Nepenthes* pitchers were collected for analysis on December 24, 2012 in thinned pine forest with predominance of *Pinus kesiya* Royle ex Gordon. The patch of forest is situated on the top of a hill, on a flat plot. Similar forest fragments with predominance of *P. kesiya* can be found in the near vicinity. All pitchers were located at one level, near ground surface.

Description of community including *Nepenthes smilesii* was made on January 07, 2013 by A.N. Demidova and N.G. Prilepsky. Density (in parts of unity) was noted for tree layer, undergrowth, and shrub layer, and total projective coverage (in percentage) was marked for suffruticose-herb layer. Pavlovskij–Braun-Blanquet visual scale of cover-abundance was used for estimation of abundance of trees, shrubs and herbs: [+] – species is poorly present (projective coverage (PC) up to 1% of the description area); [1] – considerable amount (PC forms 1-5% of area); [2] – species is abundant, but PC is lower than 25%; [3] – species is very abundant (PC is 25-50%); [4] – PC is 50-75%; [5] – complete dense cover (PC is 75-100%). Latin plant names are given according to: <http://tropicos.org>.

Coordinates of locality of material collection: 12°11'00.5"N, 108°40'45.4"E, H = 1411 m.a.s.l. Vietnam, Lam Dong province, Bi Doup mountain massif, slope near Giang Ly forest station, pine (*Pinus kesiya*) grass forest, *Nepenthes* population. Community name: pine bamboo-grass forest. Description area: 10×10 m. Density – 0.2, height of the main canopy (*Pinus kesiya*) – 12 m, diameter of tree trunks – 40-50 cm. Degree of species projective coverage is listed in brackets. Undergrowth: *Pinus kesiya*, 0.4-1 m high (1); *Schima* sp., 0.5 m high (+). Shrub layer: *Melastoma* sp., 1.5 m high (1). Total projective coverage of herb layer on sample plot: 70-80%, near *Nepenthes* population (5×5 m plot) – 40%. Herbage composition: *Poaceae* – 3 (4); *Bambusoideae* – 3; *Lycopodiella cernua* (L.) Pic. Serm. – 1-2; *Gleicheniaceae* – 1; *Nepenthes smilesii* Hemsl. – +; *Rubus* sp. – +; *Dianella* sp. – +; *Lindernia* sp. – +. On ground – thin layer of pine needles, branchlets, grass litter. Near sample area – cut down pine trees, fern thickets (Figs. 1-2).

Collected herbarium specimen of *Nepenthes* (Fig. 3) is stored in Herbarium of Moscow University (MW). Copy of herbarium label: “B17: 12°11'00.5"N, 108°40'45.4"E, H = 1411 m.a.s.l. Vietnam, Lam Dong province, Bi Doup mountain massif, to the north of Giang Ly forest station, slope, pine forest (*Pinus kesiya* Royle ex Gordon), near *Fokienia hodginsii* planting. On ground. Leg.: A.N. Kuznetsov, A.N. Demidova, N.G. Prilepsky. Det. genus: A.N. Kuznetsov, S.P. Kuznetsova, A.N. Demidova, N.G. Prilepsky. Det. species: M.S. Nuraliev. *Nepenthes anamensis* Macfarl., 1908. December 24, 2012. On 3 sheets. No. 445”. Subsequently the plant was identified as *N. smilesii* by F. Mey (F. Mey, pers. comm.).

Two fully developed pitchers 15.5 and 10.5 cm long were chosen for the study (Fig. 4). There were a certain variation in size, shape and color of the pitchers; nevertheless, since the plant was trailing without any support, all the pitchers were located at one level near the ground. Pitchers were repeatedly rinsed with alcohol and their contents were analyzed with MBS-10 (LOMO-Eltem, St. Petersburg) with 8× ocular (8×–56× magnification) and Stemi 2000C Carl Zeiss (10×–60×) stereomicroscopes. Photographs of the specimens, except ants, were made by Canon EOS 1000D camera connected to MBS-10 microscope through MFU photo adapter (LOMO-Eltem). Axiocam 105 color camera was used with Stemi 2000C stereomicroscope for ant imaging. Photos were processed in



Figure 1: General view of natural community, in which *Nepenthes smilesii* was found in Bi Doup – Nui Ba National Park (South Vietnam). Photo by Anna Demidova.



Figure 2: Character of herb layer near *Nepenthes smilesii* population. Photo by Anna Demidova.

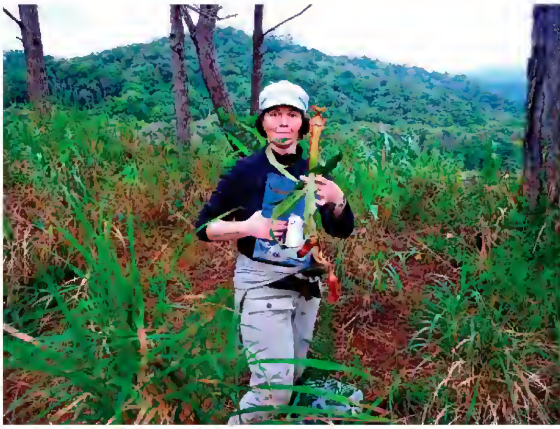


Figure 3: Herbarium specimen collecting. Anna Demidova in photo. Photo by Nikolay Prilepsky.

Helicon Focus 5.3 (z-stack) and Adobe Photoshop CS5 programs.

Results

242 specimens of invertebrates (without taking into account extremely small, unidentifiable fragments) were observed in the studied samples: 230 specimens of insects from 7 orders and 23 families, as well as 7 specimens of arachnids (2 orders), 2 specimens of chilopods, 2 specimens of isopods and 1 specimen of oligochaetes. Results of identification are listed in Table 1.

The majority of collected insects can be identified up to the family level. Representatives of Dermaptera and Auchenorrhyncha orders (single specimen of each taxon) as well as some Coleoptera and Diptera are present in the samples only as isolated body or wing fragments, so their identification was complicated.

Cockroaches, Blattodea (6.4%): Blattidae – 1 genus, 1 species; Ectobiidae – 2 genera, 3 species. Inhabitants of lower forest layer.

Orthopterans, Orthoptera (1.2%): Gryllacrididae – 1 specimen; Trigonidiidae – 2 specimens.

Heteroptera (8.9%): Lygaeidae – *Dieuches pamela* Eyles 1973 (5 males, 12 females, 2 larvae); Nabidae – *Stenonabis* sp. (2 females).

Coleoptera (1.7%): two elytra, belonging to the representatives of two families – Lycidae and Chrysomelidae (Fig. 5), others remain unidentified up to the family level (only hind wings are present). Small species.

Parasitic hymenopterans, Hymenoptera, part. Parasitica (1.7%): Charipidae, Chalcidoidea, Diapriidae, Ichneumonidae. (Fig. 6). Represented by very few specimens.

Hymenoptera: Formicidae (68.1%). Predominant group of insects in prey of these samples of *Nepenthes smilesii*. Seven species from 7 genera and 5 subfamilies were found (Table 2).

The dominant species is a background species for the study area from Dolichoderinae, *Technomyrmex yamanei* Bolton, 2007 (Fig. 7, image 1). Quite numerous colonies of this species inhabit



Figure 4: *Nepenthes smilesii* pitchers in nature (left & center). The two pitchers on the right were used for study in the laboratory. Photos by Anna Demidova.

Table 1. Taxonomic composition and abundance of invertebrates found in *Nepenthes smilesii* pitchers in Bi Doup – Nui Ba National Park in South Vietnam.

Class	Order, suborder, superfamily	Family	No. of specimens	%
Hexapoda (insects)	Blattodea:	Blattidae:	1	6.4
		Ectobiidae:	14	
	Dermaptera:		1	0.4
	Orthoptera:	Gryllacrididae:	1	1.2
		Trigonidiidae:	2	
	Hemiptera, Auchenorrhyncha:		1	0.4
	Hemiptera, Heteroptera:	Lygaeidae:	19	8.9
		Nabidae:	2	
		Others:	2	
	Coleoptera:	Lycidae:	1	1.7
		Chrysomelidae:	1	
		Others:	2	
	Hymenoptera:			
	Superfamily Cynipoidea:	Charipidae:	1	1.7
	Superfamily Chalcidoidea:		1	
	Superfamily Proctotrupoidea:	Diapriidae:	1	
	Superfamily Ichneumonoidea:	Ichneumonidae:	1	
	Superfamily Formicoidea:	Formicidae:	165	68.1
	Diptera:			5.9
	Suborder Nematocera:	Sciaridae:	8	
	Suborder Nematocera:	Mycetophilidae:	1	
	Suborder Nematocera:	Simuliidae:	1	
	Suborder Brachycera:	Phoridae:	2	
	Suborder Brachycera:	Tephritidae:	1	
		Others:	1	
Arachnida (arachnids)	Phalangida:		3	1.2
	Acarina:			1.7
	Suborder Oribatida:		1	
	Suborder Thrombidiformes:		2	
	Others:		1	
Chilopoda (chilopods)	Lithobiomorpha:		2	0.8
E crustacea (crustaceans)	Isopoda:		2	0.8
Annelida (annelids)			1	0.4
Total:			242	100

Scale = 1 mm



Figure 5: Elytra of beetles: Lycidae family (left), Chrysomelidae family (right). Identification by I.A. Zabaluev. Photo by Evgeny Shcherbakov.



Figure 6: Parasitic hymenopterans: Charipidae family (left), Ichneumonidae family [Cryptinae subfamily] (center), Wing of Diapriidae family (right). Identification by A.V. Antropov. Photo by Evgeny Shcherbakov.

dotted trees and dead wood in lower forest layer, using bark desquamations and various hollows (V.A. Zryanin, personal observation). Three other ant species from pitchers, *Crematogaster* sp., *Tetramorium* cf. *nipponense* Wheeler, 1928, *Polyrhachis halidayi* Emery, 1889 (Fig. 7, images 2-4), also belong to dendrobiont or dendrophil ecological groups. Another three, *Brachyponera* cf. *chinensis* Emery, 1895, *Cerapachys sulcinodis* Emery, 1889, and *Nylanderia* sp. 2 (Fig. 7, images 5-7) may be treated as herpetobionts (*C. sulcinodis* is specialized in raiding the nests of other ants for prey), but in the study area they also prefer to inhabit wood remains and often go up to the herb layer, which is likely the reason they were captured by the *Nepenthes smilesii* pitchers.

Table 2. Species composition and abundance of ants found in *Nepenthes smilesii* pitchers in Bi Doup – Nui Ba National Park in South Vietnam.

No.	Species	Subfamily	No. of specimens
1	<i>Polyrhachis halidayi</i>	Formicinae	4
2	<i>Nylanderia</i> sp. 2*	Formicinae	1
3	<i>Cerapachys sulcinodis</i>	Dorylinae	2
4	<i>Technomyrmex yamanei</i>	Dolychoderinae	129
5	<i>Crematogaster</i> sp. 3*	Myrmicinae	13
6	<i>Tetramorium</i> cf. <i>nipponense</i> (= <i>Tetramorium</i> sp. A)*	Myrmicinae	6
7	<i>Brachyponera</i> cf. <i>chinensis</i>	Ponerinae	10
Total:			165

*These species are readily identifiable by morphological characters on the level of local ant fauna and included in the recently published review (Zryanin, 2013) under indicated codes.



Figure 7: Ants: 1) *Technomyrmex yamanei*, 2) *Crematogaster* sp. 3, 3) *Tetramorium* cf. *nipponense*, 4) *Polyrhachis halidayi*, 5) *Brachyponera* cf. *chinensis*, 6) *Cerapachys sulcinodis*, 7) *Nylanderia* sp. 2. Scale = 1 mm. Identification and photo by Vladimir Zryanin.

Dipterans, Diptera (5.9%). Nematocera: Sciaridae, Mycetophilidae, Simuliidae; Brachycera: Phoridae, Tephritidae (Fig. 8). Mainly small, poorly flying forms.

Among mites (Acarina, 1.7%) there are at least one representative of oribatids (Oribatida) and two representatives of Thrombidiformes (Fig. 9).

Results of quantitative analysis are presented as a diagram (Fig. 10).

Discussion

Results of the taxonomic analysis of the pitcher contents, the first of its kind for *N. smilesii*, show that its nutrition is formed by a wide spectrum of invertebrates, the majority of which is inhabitants of soil surface. Only 9.4% of specimens can be referred to actively flying fauna.

As in case of majority of other *Nepenthes* species (Kato *et al.* 1993; Moran 1996; Adam 1997; Rembold *et al.* 2010; Hosoishi *et al.* 2012), ants form main constituent element of the prey. Almost

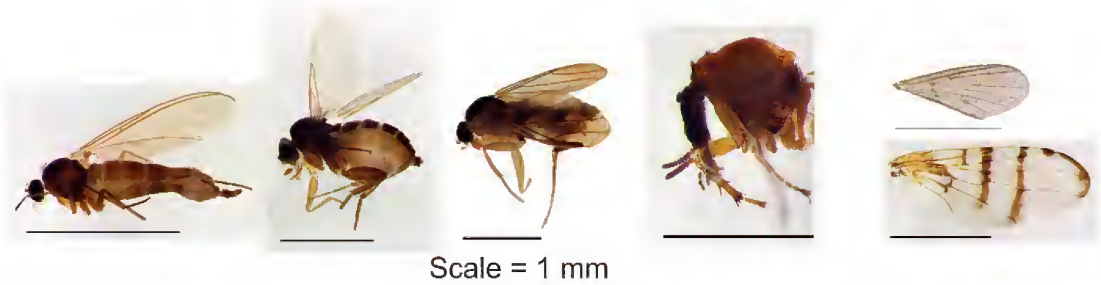


Figure 8: Dipteran (left to right): Sciariidae, Phoridae (2), head and thorax of a black fly Simuliidae, and wings of a fungus gnat Mycetophidae (above) and fruit fly Tephritidae (below). Identification by A.L. Ozerov. Photo by Evgeny Shcherbakov.



Figure 9: Mites: soil oribatid Oribatida (left), Trombidiformes (right). Identification by G.S. Eremkin and E.O. Shcherbakov. Photo by Evgeny Shcherbakov.

all ant species from pitchers are abundant in the study area (Zryanin 2013), however, *Technomyrmex yamanei* obviously predominates in the prey. This is a comparatively small species with sufficiently soft cuticula, which, in turn, can make it an appropriate prey for *N. smilesii*. At the same time, in *N. bokorensis* Mey growing in Cambodia, belonging together with *N. smilesii* to the *N. thorelii* complex, species composition of ants is characterized by the predominance (40% of all ants in the pitchers) of a relatively large *Polyrhachis (Myrma)* species (Hosoishi *et al.* 2012). Predominance of certain species of

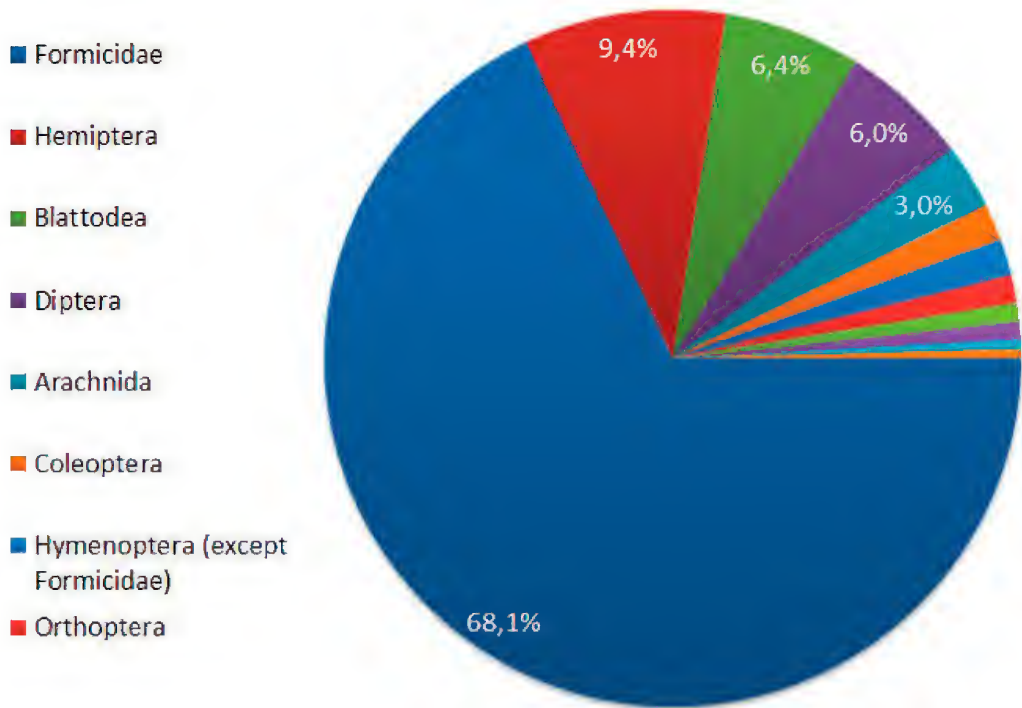


Figure 10: Quantitative composition of representatives of different invertebrate taxa in *Nepenthes smilesii* prey spectrum.

ants in pitchers was also observed in *N. rafflesiana* growing on Borneo. In the latter case, a mechanism of periodical activation and deactivation of trapping activity was described, that allows for capturing of large parties of such prey (Bauer *et al.* 2015). Probably, such mechanism exists in *N. thorelii* complex as well.

We also have myrmecological material taken from several pitchers of *Nepenthes mirabilis* (Lour.) Rafarin, 1869 in June–July 2008 in Binh Chau nature reserve (Ba Ria – Vung Tau province, Vietnam) (unpublished observations). This is the most widespread *Nepenthes* species in lowland Vietnam forests. A total of 17 species of ants from 11 genera, 5 subfamilies (identification by V.A. Zryanin) were found. Ants of four species (*Anoplolepis gracilipes* Smith, 1857, *Pheidole* cf. *plani-dorsum* Eguchi, 2001, *Ochetellus glaber* Mayr, 1862, and *Crematogaster* sp.) made from 40 to 95% of all prey of *N. mirabilis* (A.V. Tiunov, pers. comm.), i.e., on the average, the same as all ants in our study. Nevertheless, no predominance of any single species was observed.

In relation to the other (non-Formicidae) dominating groups of prey, *N. smilesii* differs strongly from other species. Second group (as far as abundance is concerned) is formed by true bugs (Heteroptera), which very rarely get into pitchers of other species with the exception of *N. lowii* Hook., where they make 8.3% of prey (Adam 1997). Moreover, the main mass is formed by only one species, *Dieuches pamela* Eyles, 1973, represented by different age groups.

Finally, 6.4% of prey is formed by cockroaches (Blattodea). Apparently, cockroaches fall into *N. smilesii* pitchers on a regular basis, which is indicated by the presence of their remains of different degrees of decay. Among other species of *Nepenthes*, cockroaches were registered in small amount for *N. × kinabaluensis* and *N. villosa* (per 3%; Adam 1997), though, as an accidental element, were singled out in other species as well (Adam 1997; Giusto *et al.* 2008). Orthopterans inhabiting the same conditions are rarer prey; maybe, as these insects have strong hind legs and are able to move by jumping, they have a certain chance to get out of the trap. On the other hand, the inner slippery surface of the pitchers may hamper the escape. Thus the reasons for the rarity of Orthoptera remain obscure at present.

Other groups (such as Coleoptera and Diptera) are notable in their relative scarcity on *N. smilesii* pitchers compared to those of other lowland species studied to date. Total absence of termites is especially noteworthy, however this may be due to their absence in this particular *Nepenthes* habitat.

We stress that the results presented here are very preliminary. Several factors may have influenced our understanding of *N. smilesii* prey spectrum as evidenced by our sample. Among the biggest are the sample size and the polymorphism of the pitchers. The first is due to the very small size of the *N. smilesii* population in the area studied, where there wasn't much possibility to collect more material. As for the possible pitcher dimorphism, we don't consider it a big factor since all the pitchers were located at one level near the ground, in the same microenvironment and in the presence of the same entomofauna. In turn, local entomofauna and its dynamics obviously influence the pitcher contents, and their contribution are notoriously difficult to study, requiring special long-term collecting efforts. Such efforts are not known for the area inside Bi Doup – Nui Ba National Park, where *N. smilesii* was studied (perhaps excluding ants). The differences in prey spectrum between *N. smilesii* and other species, hinted by our results, make perspective of future studies of all these factors very interesting.

Acknowledgments: The authors are sincerely grateful to A.N. Kuznetsov and S.P. Kuznetsova (Russian-Vietnamese Tropical Research and Technology Center, Ho Chi Minh, Vietnam) and others for assistance in organization and realization of field works. We are very thankful to François Sockhom Mey (Haubourdin, France) for identification of *Nepenthes* plants and explanation on

systematics of *Nepenthes* genus. We want to express our gratitude to the following colleagues for assistance in identification of certain groups of insects: L.N. Anisyutkin (Zoological institute of Russian Academy of Sciences, St. Petersburg (cockroaches)), A.V. Gorokhov (Zoological institute of Russian Academy of Sciences, St. Petersburg (orthopterans)), A.V. Antropov (Zoological museum of Moscow State University, Moscow (parasitic hymenopterans)), D.A. Gapon (Zoological institute of Russian Academy of Sciences, St. Petersburg (true bugs)), I.A. Zabaluev (Saratov branch of Russian Entomological Society, Saratov (beetles)), A.L. Ozerov (Zoological museum of Moscow State University, Moscow (dipterans)). We also thank A.V. Tiunov (Institute of ecology and evolution problems of Russian Academy of Sciences, Moscow) for provision of material on ants from pitchers of *Nepenthes mirabilis* collected in Binh Chau Nature Reserve; L.V. Aver'yanov (Botanical institute of Russian Academy of Sciences, St. Petersburg) for consulting on Vietnam flora, and A.Yu. Mishustin for technical assistance in photo processing.

The study is fulfilled within the framework of “Structural and functional organization of tropical rainforest communities and evaluation of modern state of biodiversity of plant and animal world” program (Ecolan E-1.2).

References

- Adam, J.H. 1997. Prey spectra of Bornean *Nepenthes* species (Nepenthaceae) in relation to their habitat. *Pertanika J. Trop. Agric. Sci.* 20 (2/3): 121-134.
- Bauer, U., Federle, W., Seidel, H., Grafe, U.T., and Ioannou, C.C. 2015. How to catch more prey with less effective traps: explaining the evolution of temporarily inactive traps in carnivorous pitcher plants. *Proceedings of the Royal Society of London B: Biological Sciences* 282:20142675: 1-8, DOI: 10.1098/rspb.2014.2675.
- Bauer, U., Willmes, C., and Federle, W. 2009. Effect of pitcher age on trapping efficiency and natural prey capture in carnivorous *Nepenthes rafflesiana* plants. *Annals of Botany* 103(8): 1219-1226.
- Bonhomme, V., Pelloux-Prayer, H., Jousset, E., Forterre, Y., Labat, J.-J., and Gaume, L. 2011. Slippery or sticky? Functional diversity in the trapping strategy of *Nepenthes* carnivorous plants. *New Phytologist* 191(2): 545-554.
- Chin, L., Chung, A.Y., and Clarke, C. 2014. Interspecific variation in prey capture behavior by co-occurring *Nepenthes* pitcher plants: evidence for resource partitioning or sampling-scheme artifacts? *Plant Signaling & Behavior* 9(1): 27-30, DOI: 10.4161/psb.27930.
- Giusto, B.D., Grosbois, V., Fargeas, E., Marshall, D.J., and Gaume, L. 2008. Contribution of pitcher fragrance and fluid viscosity to high prey diversity in a *Nepenthes* carnivorous plant from Borneo. *J. Biosci.* 33(1): 121-136.
- Hosoishi, S., Park, S.-H., Yamane, S., and Ogata, K. 2012. Species composition of ant prey of the pitcher plant *Nepenthes bokorensis* Mey (Nepenthaceae) in Phnom Bokor National Park, Cambodia. *Cambodian Journal of Natural History* 2012(1): 3-7.
- Jebb, M.H.P. 1991. An account of *Nepenthes* in New Guinea. *Science in New Guinea* 17: 7-54.
- Jebb, M.H.P., and Cheek, M.R. 1997. A skeletal revision of *Nepenthes* (Nepenthaceae). *Blumea* 42(1): 1-106.
- Jensen, H. 1910. *Nepenthes*-Tiere. II. Biologische Notizen. *Annales du Jardin Botanique de Buitenzorg*, Suppl. 3: 941-946.
- Kato, M., Hotta, M., Tamin, R., and Itino, T. 1993. Inter- and intra-specific variation in prey assemblages and inhabitant communities in *Nepenthes* pitchers in Sumatra. *Tropical Zoology* 6(1): 11-25. DOI: 10.1080/03946975.1993.10539206.
- Lloyd, F.E. 1942. *The Carnivorous Plants*. Waltham, MA: Chronica Botanica Co.

- McPherson, S. 2011. *New Nepenthes*: Volume One. Poole, England: Redfern Natural History Productions. xiv + 595 pp.
- Mey, F.S., Catalano, M., Clarke, C., Robinson, A., Fleischmann, A., and McPherson, S. 2010. *Nepenthes holdenii* (Nepenthaceae), a new species of pyrophytic pitcher plant from the Cardamom Mountains of Cambodia. In: McPherson, S. *Carnivorous Plants and their Habitats*. Volume 2. Redfern Natural History Productions, Poole. pp. 1306–1331.
- Moran, J.A. 1996. Pitcher dimorphism, prey composition and the mechanisms of prey attraction in the pitcher plant *Nepenthes rafflesiana* in Borneo. *Journal of Ecology* 84(4): 515-525.
- Moran, J.A., Clarke, C., and Gowen, B.E. 2012. The use of light in prey capture by the tropical pitcher plant *Nepenthes aristolochioides*. *Plant Signaling & Behavior* 7(8): 957-960.
- Rembold, K., Fischer, E., Wetzell, M.A., and Barthlott, W. 2010. Prey composition of the pitcher plant *Nepenthes madagascariensis*. *Journal of Tropical Ecology* 26(4): 365-372.
- Zryanin, V.A. 2013. Ecological and geographical features of ant fauna (Hymenoptera, Formicidae) on the Da Lat plateau, Vietnam. *Proceedings of the Russian Entomological Society* 84(2): 39-52. [In Russian]



PetFlyTrap.com

THE ORIGINAL VENUS FLYTRAP



- Phone/mail order and Internet U.S. sales
- Visits by appointment only
- *Dionaea*, *Drosera*, *Nepenthes*, *Pinguicula*, *Sarracenia*, books, supplies, and **much** more
- Everything is **IN STOCK** and ready to ship! (No **OUT OF STOCK** items on our site!)
- Multiple sizes of most plants
- Rare, nursery-grown, imported lowland, intermediate, and highland *Nepenthes*
- Shipped potted and ready to **GROW!!**



www.PetFlyTrap.com
service@petflytrap.com
281-433-3290
facebook.com/petflytrap

PINGUICULA RAMOSA MIYOSHI – A BOTANICAL REVIEW

HIRO SHIMAI • Tokyo Metropolitan Board of Education • Shinjuku • Tokyo • Japan • shimaihiro@gmail.com

Keywords: conservation, distribution, ecology, history, morphology, *Pinguicula ramosa*

Abstract: *Pinguicula ramosa* Miyoshi (Lentibulariaceae), endemic to Japan, is one of the most unique *Pinguicula* species often having a branched pedicel. Ecologically it occurs on cliffs formed by tuffs, porous volcanic rocks, which is also unusual as many *Pinguicula* species can be more commonly found on calcareous soils or serpentinite rocks. However, little attention has been previously given to this tiny endangered species with very few references in the literature outside of Japan, or even in there. To reveal the species, observations of the plants in situ, herbarium specimen examinations, and review of the literature have been performed. In addition, comparisons with morphologically and phylogenetically closely related species, *P. variegata* Turcz. and *P. villosa* L., will be summarized. This work is a botanical review overall *P. ramosa* discussing its morphology, distribution, taxonomy, ecology, history, conservation, and other scientific matters.

Introduction

The Genus *Pinguicula* L. (Lentibulariaceae) consists of approximately 90 species (Cieslak *et al.* 2005; Kondo & Shimai 2006), morphologically divided into three subgenera, *Isoloba*, *Pinguicula*, and *Temnoceras*, taking account of corolla shapes, sub-actinomorphic or zygomorphic, and flower colors (Casper 1966). A number of species occur in Mexico and Central America (ca. 46 species), and the rest of them are found in Eurasia, North America, South America, the Caribbean Islands, or the northern part of Africa. Many of them are restricted to a small geographical area and thus they show a higher proportion of endemism (Shimai & Kondo 2007).

At least two *Pinguicula* species are native to Japan. The first one is *P. macroceras* Link, widespread from Hokkaido to Tokushima Prefectures, but it is usually restricted to higher elevations. The scientific name is often treated as *P. vulgaris* L. var. *macroceras* (Link) Herder by Japanese botanists, but it should be segregated from *P. vulgaris* L. as Casper (1962a) discussed. *P. macroceras* is also found widely in far eastern Russia (Kamchatka, Sakhalin Island, and Kuril Islands) and the western part of Canada and the USA (Aleutians, Alaska to California). The second species is *P. ramosa*, endemic to a very small geographical area in Gunma and Tochigi Prefectures. *P. ramosa* can be easily distinguished by its smaller size and morphology from *P. macroceras*. There could be the third possible species, *P. villosa*, in Shikotan Island, one of the South Kuril Islands, lying northeast of the island of Hokkaido, but Japan has a territorial dispute on the South Kuril Islands with Russia. There have been no hitherto collection records of *P. villosa* from the main island of Hokkaido; therefore, two species, *P. macroceras* and *P. ramosa*, are generally recognized in Japan.

Literature regarding *P. ramosa* has been published in only small numbers so far particularly in English even though there are contributions to the species by some Japanese botanists. As a result, *P. ramosa* is still one of the little known species in the world. This work is, thus, attempting to review *P. ramosa*, and some different approaches have been used to achieve it. Firstly, the author

has visited localities of *P. ramosa* many times since the late 1980s to study morphology and ecology of the species in situ. For morphological studies, the plant of *P. ramosa* was photographed in its habitats and those are going to be shown in this work. Based on the material, illustrations were drawn and the author's observations are documented. Secondly, herbarium specimens deposited at A, BM, E, GMNHJ, JE, K, KYO, LE, MAK, PE, SAPS, TI, TNS, Nippon Dental University, and Tochigi Prefectural Museum have been studied and a geographical distribution map will be provided. Also, seeds from herbarium specimens were scanned by Hitachi High-Technologies Miniscope® TM3030Plus, an electron microscope. The diameter of pollen grains was measured by micrometers. Thirdly, literature published by various workers was reviewed to gather as much detail as possible about the botanical characteristics, molecular analyses, ecology, and history of *P. ramosa*.

Pinguicula ramosa Miyoshi, Bot. Mag. Tokyo 4. (1890) 315.

TYPE: JAPAN. Mount Koshin in the Province of Shimotsuke, 9 August 1890, Miyoshi s.n. (holotype?: TI!).

SYNONYM: *P. ramosa* Miyoshi f. *albiflora* Komiyama, *P. villosa* L. var. *ramosa* (Miyoshi) Tamura.

DESCRIPTION: Lithophytic. Very small perennial herb (rosette diameter at anthesis 12-25 mm). Cotyledon 1. Root waxy-white, not many, filiform, ca. 15 mm long, very delicate texture. Stem compressed. Leaf dimorphic, summer leaf 3-6, radially lying on ground, yellowish-green, lower surface sometimes faintly suffused with maroon, ovate to elliptic, margin entire, often strongly involute, apex obtuse, base widely cuneate, subpetiolate, 6-15 mm long, 5-8 mm wide, densely covered by stalked and sessile glands only upper surface, winter leaf up to 15, tightly clustered to form a hibernaculum, ovate, apex rather acute, concave, up to 5 mm long. Hibernaculum subglobose, rootless. Pedicel 1, slightly S-shaped, often bifurcate or trifurcate at below middle or near base, 15-90 mm long, densely glandulous. Calyx bilabiate, upper lip 3-lobed, lobes oblong-ovate, ca. 1 mm long, middle lobe slightly longer than laterals, lower lip 2-lobed, ovate, up to 2 mm long, connate at base, glandulous. Flower faintly pale purple to pale purple, purple veins at base of lips to tube, 1-4 yellow spots at base of middle lobe. Corolla bilabiate, 8-10 mm across, zygomorphic, 7-11 mm long including spur, upper lip 2-lobed, lobes ovate-oblong, apex obtuse, 2-3 mm long, 2-3 mm wide, lower lip 3-lobed, lateral lobes ovate to ovate-oblong, apex obtuse, slightly larger than uppers, middle lobe ligulate, convex or with verrucose crests at base, slightly reflexed, apex truncate to emarginate, 4-7 mm long, 3-5 mm wide, numerous white trichomes at base of lower lip to throat, tube purple with darker veins, conical, dorsally compressed, spur yellow, cylindrical, straight or only slightly arcuate, abruptly narrowed at apex, 2-4 mm long. Ovary subglobose. Anther 2, filament ca. 1 mm long. Pollen grain creamy-white, 5- or 6-zonocolporate, 30-33 µm in equatorial diameter. Capsule subglobose, 2.0-2.5 mm, upper margin rather flat. Seed brown, glossy, fusiform-ellipsoid, 630-980 µm long, 195-250 µm wide, surface narrowly reticulate. $2n = 18$. Figures 1, 2, and Front Cover.

PHENOLOGY: June to July

ETYMOLOGY: branched (referring to the pedicel)

LOCAL NAME: Koshin-so

1. Distribution

JAPAN. Gunma and Tochigi (1,460-2,300 m alt.).

Pinguicula ramosa is endemic to Gunma and Tochigi Prefectures. The habitat is highly restricted to several mountains and gorges, including Mt. Akanagi-san, Mt. Kesamaru-yama, Mt. Koshin-zan, Mt. Nokogiri-yama, Mt. Nyoho-san, Unryu-keikoku Gorge, and Misawa Rivulet, all of which are

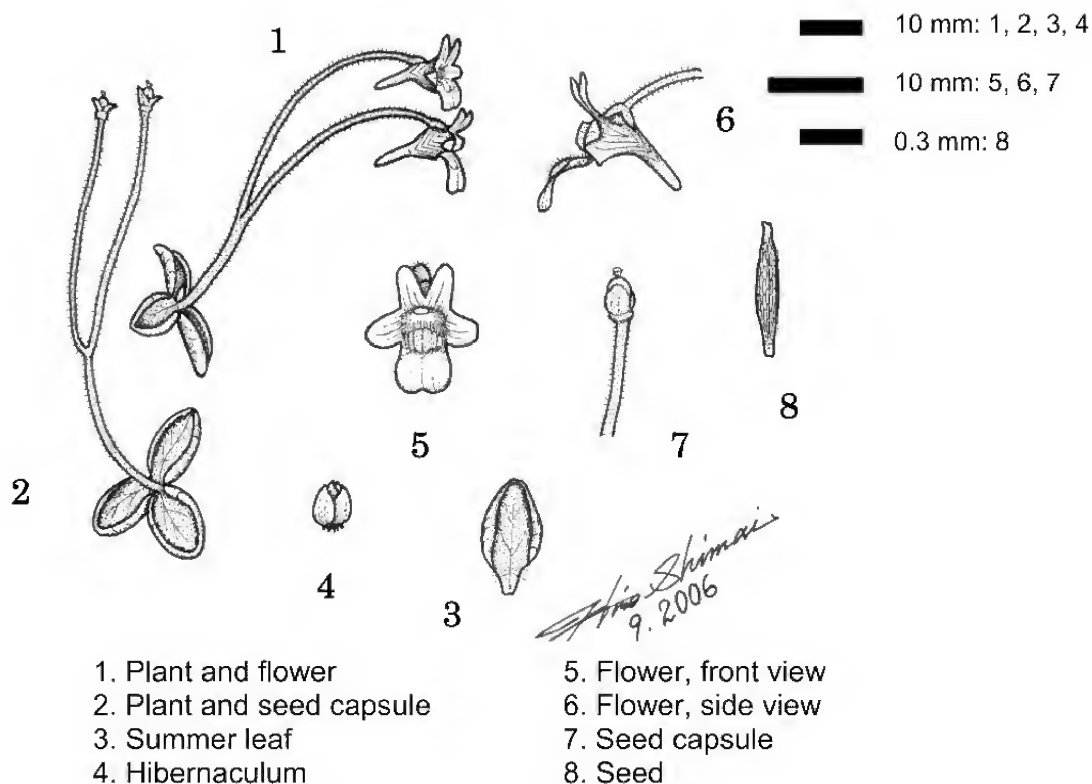


Figure 1: *Pinguicula ramosa* morphological line drawings.

located in Nikko National Park except Mt. Kesamaru-yama. Those habitats are within a boundary of Tochigi Prefecture with the exception of one locality in the Gunma side of Mt. Kesamaru-yama. The type locality mentioned in the original description as the Province of Shimotsuke (or Yashu in other old literature or specimen labels) is almost identical with Tochigi Prefecture today. The distribution pattern is shown in a map (Fig. 3) based on the author's herbarium specimen examinations. It is basically agreed with maps previously presented by Komiya and Shibata (1980, 1999), but additional localities have been indicated.

Uploading the coordinate datasets of habitats mentioned above into GeoCAT (Royal Botanic Gardens, Kew), it showed that Extent of Occurrence (EOO) was 63.098 km² and Area of Occupancy (AOO) was 40.000 km², implying a very narrow appearance.

Regarding the altitudinal distributions, the lowest height shown on specimen label is 1,250 m, but it is more reliably above 1,460 m. The highest habitat is ca. 2,300 m at Mt. Nantai-san.

2. Taxonomy

P. ramosa is uniform with no morphological variants. Although an unbranched pedicel is commonly produced (53%; investigated at Mt. Nantai-san), the species often has a bifurcate (46%) or trifurcate pedicel, which is absolutely uncommon for the other species in the genus. Branching very likely depends on availability of water and nutrition. Taxonomic studies were previously attempted by a few workers. Tamura (1953) treated as *P. villosa* L. var. *ramosa* (Miyoshi) Tamura without any clear statements. On the other hand, Ernst (1961) thought that *P. ramosa* was synonymous with *P. variegata*, but morphological and ecological differences between the two species were later well-summarized by Komiya and Shibata (1998). Casper (1962b, 1963, 1966) recognized *P. ramosa* as a distinct species. For an infraspecific treatment, Komiya (1972) reported *P. ramosa* Miyoshi f. *al-*

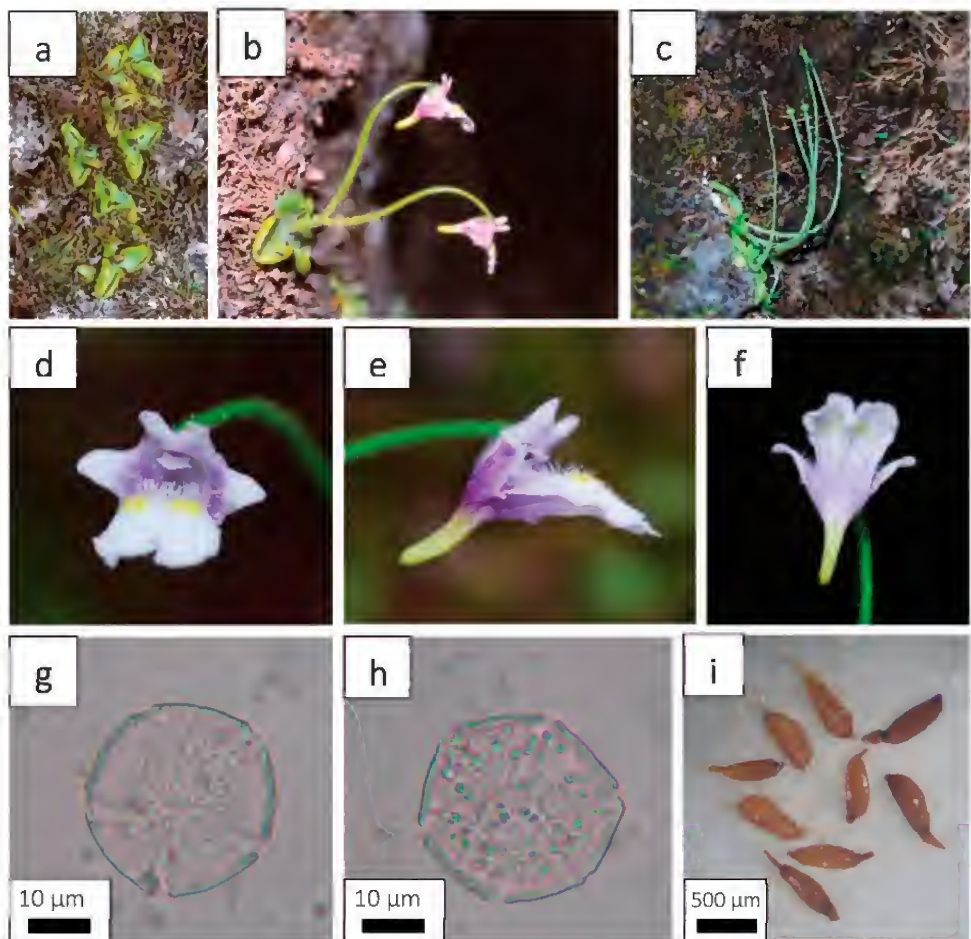


Figure 2: a) rosettes with flower bud at Mt. Nantai-san [9 June 2001], b) *P. ramosa* in flower at Mt. Koshin-zan [10 June 2002]: pedicel developing against rock wall, c) *P. ramosa* in fruit at Mt. Koshin-zan [18 July 2011]: pedicel standing upward parallel to rock wall, d) flower, front view, at Mt. Koshin-zan [17 June 2015], e) flower, lateral view, f) flower, bottom view, g) pollen grain with 5 pores, h) pollen grain with 6 pores, i) seeds.

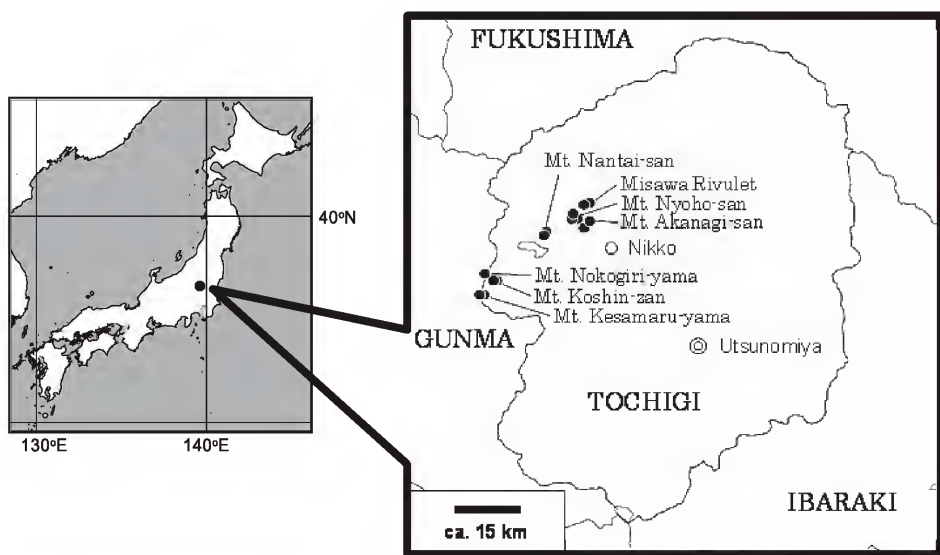


Figure 3: Geographical distribution of *Pinguicula ramosa*.

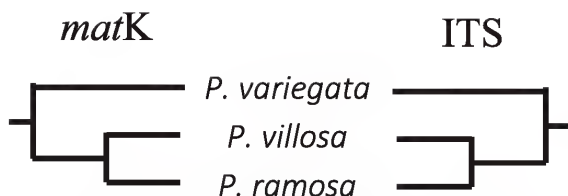


Figure 4: Phylogenetic relationships among *P. ramosa*, *P. variegata*, and *P. villosa*.

that *P. ramosa* was synonymous with *P. variegata*, did not recognize any subgeneric ranks and placed it into the Section Pionophyllum. Casper (1962b) placed *P. ramosa* into the Section Micranthus in the Subgenus *Micranthus* though Casper (1963, 1966) later moved the Section Micranthus into the Subgenus *Temnoceras*. Since a revision of the Genus *Pinguicula* by Casper (1966) no major taxonomic work over all of the genus with scientific basis has been made and consequently *P. ramosa* is still placed in the Section Micranthus, Subgenus *Temnoceras*.

According to molecular phylogenetic analyses, *P. ramosa* seems to be a close relative to *P. variegata*, distributed in Siberia to Kamchatka, and *P. villosa*, very widely distributed in the subarctic regions of Eurasia and North America, inferred from *matK* in chloroplast DNA (Cieslak *et al.* 2005; Beck *et al.* 2008) and ITS in nuclear ribosomal DNA sequences (Kondo & Shimai 2006). Those are partially extracted and presented together in Figure 4.

3. Seed

Seed shapes may vary but mostly fusiform-ellipsoid (rarely subclavate) with narrowly reticulated surface (Fig. 5). The mean seed size measured was 753 μm in length and 219 μm in width which was much narrower than that of *P. variegata* 1,042 \times 300 μm or *P. villosa* 1,079 \times 656 μm (Shimai, unpublished). Those seed characteristics are summarized in Table 1 as well as other morphological features.

The mean number of seeds per capsule was 56.4 ± 20.3 which contained mature seeds 77.7%, immature seeds 3.8%, and sterile seeds 18.6% (Oba *et al.* 2013). This amount was more than that in *P. villosa* (Swedish materials), which was 29 ± 11 (Karlsson 1986).

More than 80% of seeds stored at either -20°C or 20°C both maintained in dried air humidity had germination ability after 10 months (Oba *et al.* 2013). It is questionable, but Oba *et al.* (2013) also reported that the seed totally lost its germination ability after one month stored under 20°C without air humidity controls (i.e. higher air humidity).

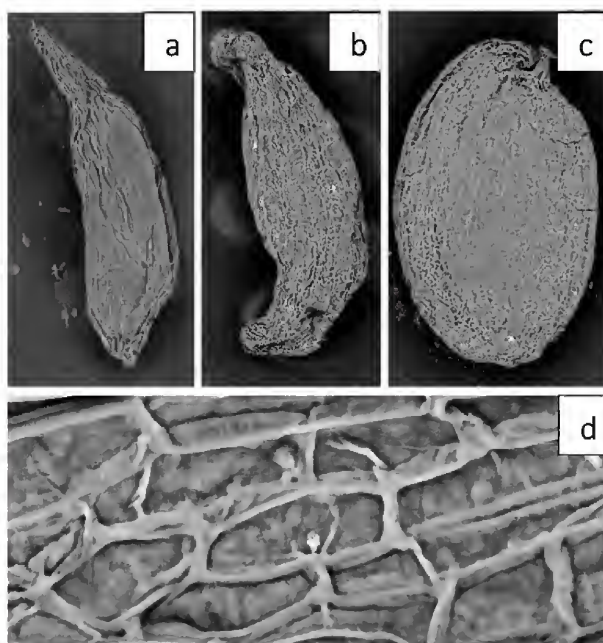


Figure 5: Seed morphology of three *Pinguicula* species. a) *P. ramosa* (ca. 750 μm long \times 200 μm wide) from Mt. Koshin-zan, b) *P. variegata* (ca. 950 μm long \times 330 μm wide) from Sakhalin Island, Russia, c) *P. villosa* (ca. 950 μm long \times 580 μm wide) from Sweden, d) seed coat of *P. ramosa*.

Table 1. Comparisons among <i>Pinguicula ramosa</i> , <i>P. variegata</i> , and <i>P. villosa</i> .				
		<i>P. ramosa</i>	<i>P. variegata</i>	<i>P. villosa</i>
Subgenus		<i>Temnoceras</i>	<i>Temnoceras</i>	<i>Pinguicula</i>
Section		Micranthus	Micranthus	Nana
Stem L		very short	very short	up to 4 cm
Summer leaf	number	3-6	3-7	1-5
	lamina shape	ovate to elliptic	ovate to orbicular	elliptic
	size L × W (mm)	6-15 × 5-8	6-20 × 5-7	7-13 × 3-7
	color	yellowish-green	yellowish-green or maroon	yellowish-green
	base shape	widely cuneate	widely cuneate	narrowly cuneate
Flower	pedicel L (mm)	15-90	30-250	15-95
	pedicel shape	branched	unbranched	unbranched
	color	pale purple	pale purple	reddish-purple
	corolla L with spur (mm)	7-11	4-17	5-11
Seed	capsule shape	subglobose	obovoid	subglobose to obovoid
	shape	fusiform-ellipsoid	fusiform-ellipsoid	ellipsoid
	size L × W (μm)	630-980 × 195-250	970-1,180 × 230-330	990-1,140 × 610-720
Chromosome number		2n = 18	2n = 64	2n = 16
Distribution area		Japan	Eastern Russia	Eurasia & North America
Altitude (m)		1,460-2,300	0-1,800	0-1,400
Climate zone		Temperate	subarctic	subarctic
Environment		forest	bog, streamside	bog, streamside
Soil types		tuff	gravelly soil or sphagnum mat	sphagnum mat

4. Cytology

The chromosome number for *P. ramosa* has been counted as $2n = 18$ by Yoshimura (1973), using materials from Mt. Nyoho-san (Unryu-keikoku Gorge?). Casper and Stimper (2009) also counted $2n = 18$ using materials from Mt. Nyoho-san. However, it will need a critical review since the basic chromosome number of $x = 9$ is unusual in the genus (mostly $x = 8$ or 11). Yoshimura (1973) suggested that $2n = 18$ might have originated from $2n = 22$ as a result of fusion, but no species with $2n = 22$ have been known so far from Eurasia. Chromosome number reported in *P. variegata* is $2n = 64$ (Zhukova & Tikhonova 1971) and that in *P. villosa* is $2n = 16$ (Löve & Löve 1982).

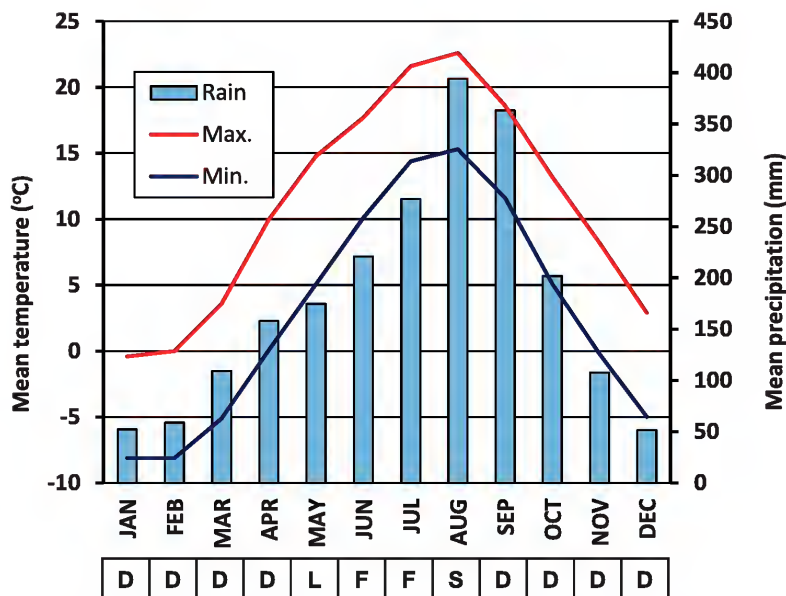


Figure 6: Monthly mean precipitation and maximum and minimum temperatures at Oku-Nikko. D: dormancy, F: flowering, L: leaf development, S: seed dispersal.

5. Natural hybrid

No natural hybrid of *P. ramosa* has been recorded though *P. ramosa* occurs sympatrically with *P. macroceras* at Mt. Nantai-san. The best explanation for this could be that they are genetically not close to each other to produce a hybrid.

6. Climates

The distribution is highly restricted to subalpine zones of several volcanic mountains and their environments lying within ca. 30 km, including Mt. Nantai-san, Mt. Nyoho-san, Mt. Kesamaru-yama, and a few other mountains as well as the type locality of Mt. Koshin-zan, around the City of Nikko (ca. 120 km north of Tokyo). Like the majority of Japan, the Nikko region has four very clear seasons. The Nikko region is much cooler in summer and colder in winter than coastal regions because of higher elevation. Monthly mean precipitation, maximum and minimum temperatures, recorded at Oku-Nikko Meteorological Station (36°44.3'N 139°30.0'E, 1,292 m alt.), on the eastern shore of Lake Chuzenji-ko, are shown in Figure 6. Annual mean temperature between 1981 and 2010 recorded at the station was 6.9°C and annual mean precipitation was 2,176.3 mm in the same period. More rainfall is generally apparent in summer than other seasons and there is some snowfall in winter. It should be noted that all localities of *P. ramosa* are 150-1,000 m higher than the meteorological station, so that the temperature at the habitat is lower than the data presented in the chart. In winter, the minimum temperature sometimes drops below -20°C and the rock walls are not covered by snow.

7. Ecology

Pinguicula ramosa is basically found on weathered tuffs, such as welded tuffs, formed by volcanic activities, often vertical or overhanging cliffs with or without mosses on the surface. Soil pH measured at Tsuru-iwa rock, Mt. Koshin-zan, was 6.0 and that at Mt. Nantai-san was 6.5. The soil is not too wet or rather dry, but frequent fogs and higher air humidity provide moisture to the plant

and the rock surface. The irradiance level at the habitats is relatively low since those are mostly located below forest lines. It is commonly seen together with *Saxifraga fortunei* var. *alpina*, *Primula farinosa* subsp. *modesta*, *Parnassia palustris*, or *Schizocodon soldanelloides* at microhabitats. The soil composed by tuff contains poor organic substances restricting to grow only a few plant species including *P. ramosa* and those mentioned above. Usually *P. ramosa* is not exposed to direct sunlight, hence it is tolerant to low light intensity and higher air humidity. In contrast, *P. variegata* and *P. villosa* are often found on sphagnum mats in bogs or along streams in open areas.

8. Pollination

The flower of *P. ramosa* is very likely entomophily but what kind of insects are actually pollinating has remained unknown (flies are seen at the habitat). Despite that, most of flowers are successfully pollinated. Yellow spots at the base of middle lobe of lower lip and nectar held in a spur may have important roles to attract pollinators. Ultraviolet reflection patterns on flowers might also have a role to attract pollinators as suggested by Gloßner (1992). In any case, it is probable that there is almost no chance of gene flow among isolated habitats.

9. Growth cycles

In general, a mature plant of *P. ramosa* breaks its dormancy in May and starts to expand summer leaves. A flower bud usually becomes visible when the third summer leaf is expanding. A pedicel elongates gradually against the rock wall where the plant grows, and it reaches anthesis between the beginning of June and the beginning of July. Two flowers open almost at the same time on the bifurcate pedicel. Peak flowering season varies among localities, but it normally ends within 10 days at each microhabitat. When seed setting is successfully completed, the base of pedicel curves upward and the pedicel stands nearly parallel to the rock wall. Some pedicel elongation occurs simultaneously as seeds are developing. The seed is mature approximately 1.5-2 months after anthesis and the seed capsule is naturally open vertically when it is dried. Seed dispersal is gravitational whereas only a small number of seeds are successfully deposited on the rock wall. Those stages may slightly vary year to year due to weather conditions (see also Fig. 6).

After seed germination, it normally takes three years to reach a reproductive phase in situ. Seed germination takes place in the first year. This may occur immediately after seed dispersal, or the next growth season in the following year. Seedlings become larger but remain vegetative in the second year. They are tolerant enough to low temperature at this stage when they have formed a hibernaculum since the rock walls are often not

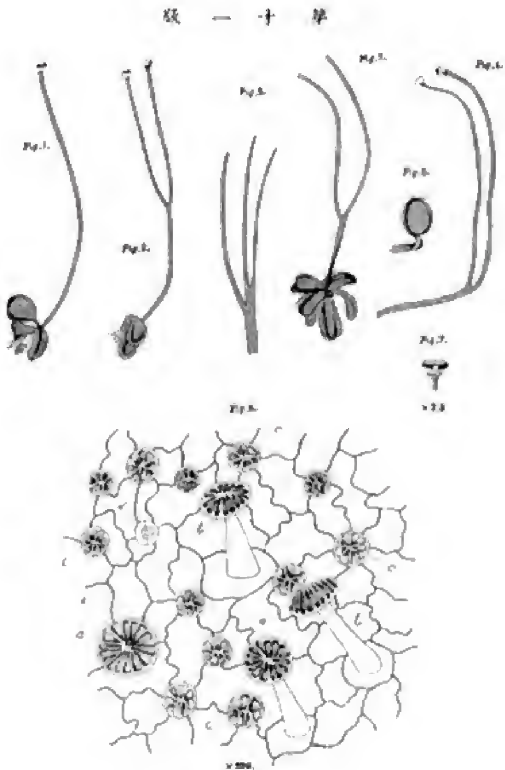


Figure 7: Drawings of *P. ramosa* in the original description by Miyoshi (1890).

covered by snow and are exposed to harsh weather conditions during winter. Flower primordia may occur when a hibernaculum is formed but further flower bud development may not take place unless it experiences low temperature in a certain period. Finally the plant may be able to flower in the third year. The mean rosette diameter at anthesis was 17.7 mm at Tsuru-iwa rock, Mt. Koshin-zan, and 18.5 mm at Mt. Nantai-san. The seed does not require low temperature (ca. 0°C) before germination, but the seedling germinated immediately after seed dispersal tends to have a lower survival rate for the next growth season. Although *P. ramosa* is perennial, how many years mature plants normally can live remain uncertain, but it seems that they could survive three years or so.

10. Hibernaculum induction

According to Oba *et al.* (2013), *P. ramosa* formed a hibernaculum under either short-day length (SD; 8 hours) or low temperature (LT; 5°C). The hibernaculum is usually formed by the end of August in situ under long-day length (LD) and high temperature (HT). It is unclear whether SD or LT is one of the factors affecting hibernaculum formation, but it is probable that after developing a certain number of summer leaves (e.g. 5-6), the plant would naturally form a hibernaculum regardless of day length or temperature that has been confirmed *in vitro* conditions under LD (18 h) and HT at 20°C throughout. Once the hibernaculum has been formed, it will stay in dormancy tolerant to LT (around 0°C or lower) and/or dryer soil moisture. It will, however, break dormancy within 40-60 days if those conditions are not fulfilled.

Asexual reproduction by gemmae or daughter hibernacula formed at the base of the main hibernaculum as seen in some other *Pinguicula* species is not active.

11. Carnivory

Like those of other *Pinguicula* species, the upper surface of leaves and a pedicel are densely covered by two types of tiny glands, i.e. stalked and sessile glands. Stalked glands secrete mucilage to capture prey, and sessile glands secrete digestive enzyme and absorb digested substance (Heslop-Harrison 1970). During the flowering season, the margins of leaves are often strongly incurved and only a small number of prey can be captured by the leaf itself. However, the pedicel may have a more important role to capture prey. After ending the flowering season, the leaf tends to be open and it captures more prey than during the flowering season. The size of prey captured is usually very minute, such as mites or springtails. No mycorrhizal organisms associated with the root have been detected so far for *Pinguicula* (Juniper *et al.* 1989; Heslop-Harrison 2004), implying that carnivory may play an important role for nutrient uptake though its efficiency is unknown.

12. History

It is believed that the first discovery of *P. ramosa* was made by Manabu Miyoshi (1862-1939), at Tokyo Imperial University (The University of Tokyo), during his botanical expedition in 1890. While on his one-month-long expedition, Miyoshi saw *P. macroceras* in Nagano. At Mt. Koshin-zan, his final destination, Miyoshi found a number of tiny *Pinguicula* growing on a rock cliff named Fuji-sengen on the mountain trail between Koshin-sanso Hut and the summit. He was not sure if it was certainly a new species since the flowering season had been over at the time of discovery in August. However, he was reasonably confident that it was likely a new species having a branched pedicel. As soon as returning to the university, Miyoshi (1890) described this taxon as *Pinguicula*

ramosa sp. nov. in Botanical Magazine Tokyo, Vol. 4, No. 43, pp. 314-319 with drawings (Fig. 7), issued in September 1890, and at the same time gave a Japanese name, *koshin-so* (literally “koshin plant”) derived from the name of mountain. In the article, Miyoshi (1890) stated the discovery of *P. ramosa* at Mt. Koshin-zan in details both in English and Japanese. The type specimens (Fig. 8) have been preserved at Botanical Gardens, Koishikawa, the University of Tokyo (TI). Miyoshi (1890) expected to observe the flower in the next flowering season and to compare anatomically with the flower of *Pinguicula macroceras* (as *P. vulgaris* in his paper), more widely distributed in Japan, but it does not seem such a study has been published. An additional sampling was made by Miyoshi in July 1891 at Mt. Koshin-zan (the specimen without flowers has been deposited at TNS), but it is probable that he did not have a chance to observe the flower at the habitat.

Prior to Miyoshi’s type specimen (9 August 1890), Kinashi collected *P. ramosa* in July 1890, which was initially identified as *P. vulgaris* and the specimen has been deposited at KYO. If the date was correct, Kinashi’s material had been collected a few weeks earlier than Miyoshi’s type specimen. Nothing was, however, documented in the literature regarding Kinashi’s specimen and it has remained unclear. According to Komiya (pers. com.), it was very likely that Kinashi misdated the label. Therefore, it is normally considered that Miyoshi was the first botanist, who collected the species. Shortly after the discovery of *P. ramosa* by Miyoshi (1890), a number of botanists visited the habitat at Mt. Koshin-zan to collect the plant. By early in the 20th century, a few other habitats, such as Mt. Nyoho-san and Mt. Nantai-san, were discovered by other botanists. More recently, new localities were found along the Misawa Rivulet, on the northern slope of Mt. Akanagi-san.

13. Ethnobotany and iconic uses

No ethnobotanical use of *P. ramosa* has been recorded since the species occurs in mountains isolated from areas of human activity. In the recent years, apart from using the plant itself, illustrations of *P. ramosa* are sometimes used for symbolic icons of the Ashio region. For example, *P. ramosa* is painted on local pottery called Ashio-yaki, or local shops sell posters of *P. ramosa* photographed at Mt. Koshin-zan for visitors. In 1978, a commemorative postage stamp with illustrations of *P. ramosa* (Fig. 9), one of the Nature Conservation Series, was issued by the Ministry of Post and Telecommunications. In 1982, Ashio Town designated that *P. ramosa* was a symbolic flower for the town and it continued until the town was merged into Nikko City in 2006.

14. Conservation

No *Pinguicula* species are listed in CITES Appendixes for international commercial trade (von Arx *et al.* 2001, and also see CITES website for an updated checklist). *P. ramosa* is, however, one of the threatened species. GeoCAT indicated that Critical (CR) for EOO and Endangered (EN) for AOO while Red List assessment by GeoCAT does not consider the number of individuals at each habitat. *P. ramosa* is actually listed in the Red List as Vulnerable (VU) status by the Ministry of the Environment. Similarly it is also listed as the same status in local versions of Red Lists issued by Gunma and Tochigi Prefectures, to protect the species under bylaws. Most of *P. ramosa* habitats are located in “special areas” of Nikko National Park (114,753 ha), environmentally protected by the Natural Park Law. Furthermore, each forest area is under control by either Forestry Agency or local administrations depending on the area. The habitat of *P. ramosa* on Mt. Koshin-zan was designated a Natural Monument in 1921 to protect not only the species itself but also the environment where the species occurs, and it has been elevated to a “special” rank since 1952. Therefore, it is heavily

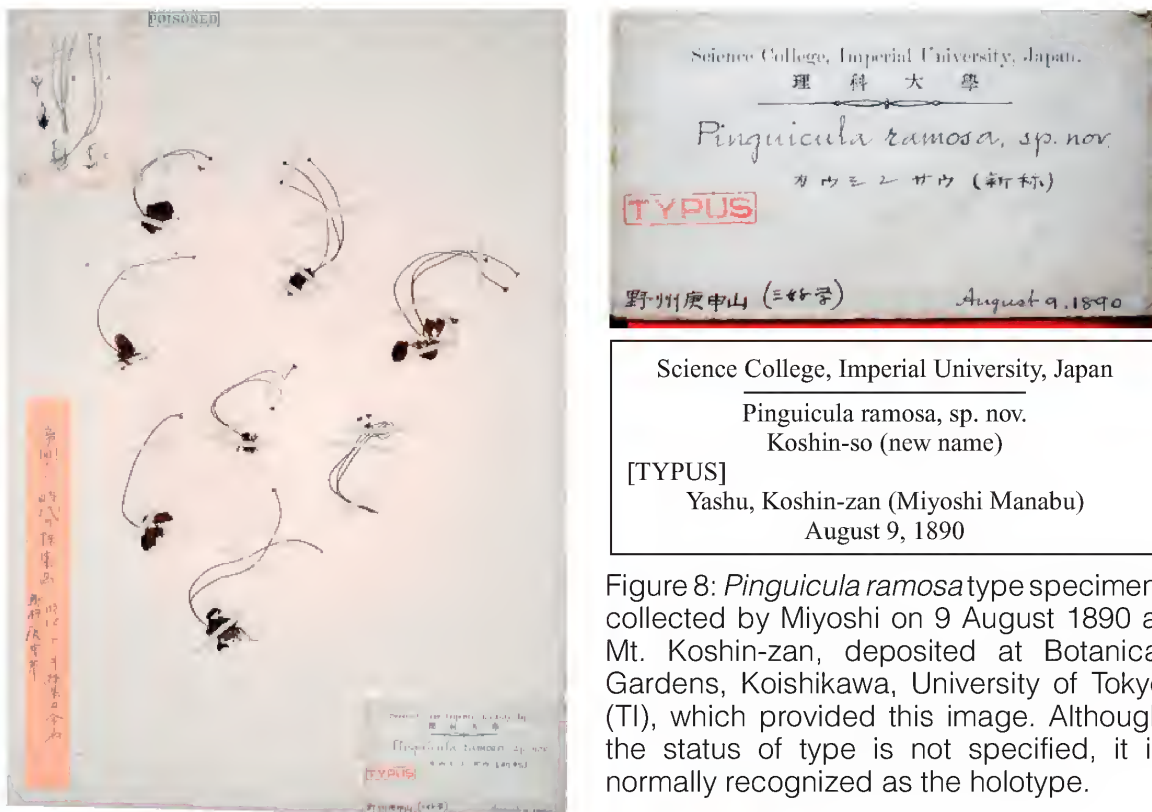


Figure 8: *Pinguicula ramosa* type specimen, collected by Miyoshi on 9 August 1890 at Mt. Koshin-zan, deposited at Botanical Gardens, Koishikawa, University of Tokyo (TI), which provided this image. Although the status of type is not specified, it is normally recognized as the holotype.



Figure 9: *Pinguicula ramosa* postage stamp and its First Day Cover.

protected by different regulations and laws directly or indirectly. Apart from legal protections, little has been attempted with effective and practical approaches for conservations of the species.

The number of *P. ramosa* individuals may occasionally decrease suddenly at the microhabitats. One possible reason could be that it is stolen by plant vendors or amateur plant collectors. Wild animals, e.g. deer or serows, may devour it together with other plant species when their food is scarce. However, most plants grow on unreachable overhanging rock cliffs and therefore such activities may not necessary be direct causes. It is likely that environmental changes at microhabitats such as dryness or corruption of rocks may be possible direct causes. Global warming and acid rain could also be factors that cannot be ignored. Recently, the population at the Gunma side of Mt. Kesamaru-yama is nearly critical (Ohmori, pers. com.).

15. Cultivation

P. ramosa forms relatively large colonies (up to a thousand individuals on a rock) on slightly wet weathered tuff cliffs, but has a higher risk of rapid decline of the population number at the habi-

Table 2. Composition of medium for <i>Pinguicula</i> culture.	
Compound	g/l
HYPONeX® 6.5-6-19	3.0
sucrose	32.0
agar	8.4
pH 5.8	

worth establishing cultivation methods for ex situ conservation of the species.

Concerning a type of compost, using soils from the habitat may be an option, but it seems, for some reason, that *Pinguicula* does not always grow well for long periods on the soil under cultivation. In Japan, sphagnum moss is very widely used for cultivation of *Pinguicula*. Also some other types of compost are commercially available, but it is not easy to say which one is the most suitable. It is not simply a question of soil types, but a whole set of environments including optimum temperatures, moistures, irradiance levels, ventilations, and pest and disease controls. Under cultivation, grey mold is the most common disease and the slug is the most problematic pest.

Another possible and more successful approach is *in vitro* culture. Many *Pinguicula* species grow successfully and multiply profusely *in vitro* condition. It is much easier to obtain plants from seeds than buds. The seeds in a tube can be disinfected by shaking for a few minutes in 10% kitchen bleach solution, and should be carefully rinsed with sterile distilled water. Kano's medium (Kano 1965), or more often called Hyponex medium, was modified for *Pinguicula* culture (Shimai, unpublished). The modified Kano's medium component is very simple, which includes granule fertilizer HYPONeX® N-P-K = 6.5-6-19 (HYPONeX Japan Corp. Ltd., Osaka, Japan) 3.0 g, sucrose 32.0 g, and agar 8.4 g per liter (Table 2). No hormones are basically required. It appears that pH level is not an absolute factor, but it should be adjusted to pH 5.8. It produces clones and multiplies very quickly on this medium, so using wider jars is much better than test tubes. Those should be maintained under 18 hours of fluorescent light. Illuminating white LEDs may perform similarly. Optimum temperature appears to be 18-20°C, but no problems have been observed under 25°C. Acclimatization is rather difficult, but to take out the *in vitro* cultured plant that has formed a hibernaculum in late autumn and to overwinter as a dormant condition in a pot may result in higher survival rates than in other seasons.

16. Representative localities

As shown in the distribution map (Fig. 3), *P. ramosa* occurs in several mountains and those environments which are mostly in Nikko National Park. Two representative localities, Mt. Koshin-zan and Mt. Nantai-san, will be described.

- 1) Mt. Koshin-zan (1,892 m) is located near Ashio, an old copper mining town, almost at the western edge of Tochigi Prefecture. Mt. Koshin-zan forms the Ashio Mountain Range together with Mt. Kesamaru-yama (1,961 m), Mt. Sukai-san (2,144 m), and some other mountains. Mt. Koshin-zan itself has been worshipped as a deity for more than 1,200 years. It was also known as a place where shugendo followers practiced mental and physical training because of a rocky mountain. As mentioned earlier, the first discovery of *P. ramosa* was made at Fuji-sengen rock along the mountain trail between Koshin-sanso Hut and the summit. It

tat due to environmental stresses and/or climate changes as already stated. Long-term cultivation of *P. ramosa* ex situ is difficult since it is not possible to provide an appropriate environment artificially. Moreover, it is strongly prohibited to collect the plants, seeds, or any segments of the plant at the habitats, and it is basically very difficult to obtain permissions. However, European vendors occasionally sell *P. ramosa* plants or seeds for a commercial purpose. It would be

is, however, not very common to see *P. ramosa* along the trail anymore. Today a number of populations are more frequently observed along Oyama-meguri trail (Miyoshi also visited a part of this trail in 1890). This loop trail goes up from Old Sarutahiko-jinja Shrine site, ca. 200 m below Koshin-sanso Hut and meets the trail to the summit above the hut through very rocky slopes and cliffs. There are many habitats along Oyama-meguri trail, but one of the best places to observe a number of *P. ramosa* plants could be on vertical or overhanging rock walls of Kame-iwa (Turtle rock) and Tsuru-iwa (Crane rock), which are almost next to each other, at an altitude of ca. 1,750 m. Those habitats are more or less facing south. Peak flowering season at the habitats is usually in the first half of June (It used to be around the 20th of June in the 1980s, but it is around the 10th of June in recent years though it may vary year to year).

- 2) Mt. Nantai-san (2,484 m), formerly called Mt. Futara-san, is one of the mountains belonging to the Nikko Volcanic Mountain Range, together with Mt. Akanagi-san (2,010 m), Mt. Nikko-Shirane-san (2,578 m), Mt. Nyoho-san (2,483 m), and some other mountains. Mt. Nantai-san itself is considered as a deity of Futarasan-jinja Shrines, situated at Chugushi at the base of the mountain and in Nikko city center. Mt. Nantai-san is located at approximately 12 km west-northwest of Nikko city center and just north of Lake Chuzenji-ko, which is a dammed lake formed by volcanic activities of the mountain ca. 20,000 years ago. Mt. Nantai-san, a stratovolcano, is conical shaped with a broken crater at the top and many radial hollows between ridges. The main habitat of *P. ramosa* is found in Hanage-no-nagi hollow, just east side of a mountain trail at the northern slope of the mountain, below the summit around 2,200-2,300 m alt. The habitat is not visible from the mountain trail because it is hidden by birch trees (*Betula ermanii*). Peak flowering season at this habitat is the beginning of July. Plant size of the population at Mt. Nantai-san is slightly larger and the pedicel is more frequently branched compared with those at Mt. Koshin-zan. This is probably due to environmental factors such as availability of water and/or soil nutrition. Apart from altitude, the environment is very similar to that of Mt. Koshin-zan (i.e. soil type, light intensity, etc.). It is the only known microhabitat where *P. ramosa* and *P. macroceras* occur sympatrically.

Key to species

1. Flower color reddish-purple, tube narrowly cylindrical, base of leaf narrowly cuneate (Eurasia & N. America) ----- *P. villosa*
1. Flower color faintly pale purple to pale purple, tube conical, dorsally compressed, base of leaf broadly cuneate ----- 2
2. Middle lobe of lower lip broadly rotundate, pedicel not branched, often suffused with maroon, up to 25 cm long, leaf yellowish-green or maroon entirely, ovate to orbicular (E. Russia) ----- *P. variegata*
2. Middle lobe of lower lip ligulate, tip truncate to emarginate, pedicel often bifurcate or trifurcate, yellowish-green, up to 9 cm long, leaf yellowish green, lower surface sometimes faintly suffused with maroon, ovate to elliptic (Japan) -- *P. ramosa*

Specimens examined

Pinguicula ramosa Miyoshi

JAPAN. Gunma: Midori, Mt. Kesamaru-yama, 14 June 1974, Sudo s.n. (GMNHJ); 29 June 2003, Shibata s.n. (Herb. Dept. Biol., Nippon Dental Univ.). Midori, Mt. Kesamaru-yama, Ato-Kesamaru-yama, source of Konaka River, 1,780 m, 28 June 2009, Yoshii *et al.* s.n. (GMNHJ). Tochigi: Ashio (Nikko), Mt. Kesamaru-yama, 1,830 m, 24 July 1985, Ogura *et al.* s.n. (Tochigi Pref. Museum).

Ashio (Nikko), Mt. Koshin-zan, July 1890, Kinashi s.n. (KYO; as *P. vulgaris*); 30 July 1891, Hori s.n. (MAK); July 1891, Miyoshi s.n. (TNS); July 1891, Sakurai s.n. (TNS); 20 July 1909, Sakurai s.n. (LE); 18 June 1910, Kurihara s.n. (GMNHJ); 5 July 1912, Shimazu s.n. (TI); 2 August 1912, Koidzumi 69204 (TNS); 15 August 1913, Imai s.n. (TNS); July 1914, Takamatsu s.n. (SAPS); 20 July 1918, Shimazu s.n. (TI); 31 July 1921, Ogura s.n. (TI); 2 August 1921, Ogura s.n. (TI); 15 July 1952, Haginiwa s.n. (TNS); 22 July 1952, leg. ign. s.n. (K); 22 June 1954, Higuchi s.n. (GMNHJ); 6 August 1954, Moriya s.n. (Tochigi Pref. Museum); 31 June 1957, Komiya s.n. (TNS); 1,750 m, 26 June 1966, Michikawa 8154-8155 (TNS); 1,400-1,800 m, 4 July 1970, Furuse 49227 (PE); 2 June 1982, Nemoto s.n. (Tochigi Pref. Museum); 1,700 m, 3 June 1984, Ogura s.n. (Tochigi Pref. Museum); 1,720 m, 11 July 1984, Ogura & Noguchi s.n. (Tochigi Pref. Museum); 15 June 1997, Shibata s.n. (Herb. Dept. Biol., Nippon Dental Univ.); Ashio (Nikko), Mt. Koshin-zan, SE slope, 1,700 m, 22 June 1986, Ogura s.n. (Tochigi Pref. Museum). Ashio (Nikko), Mt. Koshin-zan, near summit, 1,850 m, 1 September 1989, Ogura s.n. (Tochigi Pref. Museum). Ashio (Nikko), Mt. Nokogiri-yama, 14 August 1984, Hasegawa s.n. (Tochigi Pref. Museum); 1,950 m, 7 August 1986, Noguchi *et al.* s.n. (Tochigi Pref. Museum). Nikko, Mt. Akanagi-san, near Akanagi-okusha-ato, 2,100 m, 30 June 2001, Nazuka s.n. (Tochigi Pref. Museum). Nikko, Mt. Akanagi-san, Hinata, 7 September 1904, Takeda s.n. (TNS). Nikko, Mt. Akanagi-san, Oku-Akanagi-san, 2,000 m, 11 August 1984, Ogura s.n. (Tochigi Pref. Museum). Nikko, Kami-Kuriyama, upper stream of Misawa Rivulet, 1,460 m, 23 August 1989, Noguchi *et al.* s.n. (Tochigi Pref. Museum); 1,460 m, 23 August 1989, Ogura *et al.* s.n. (Tochigi Pref. Museum); 1,950 m, 20 July 1992, Yamashita s.n. (Tochigi Pref. Museum); 1,950 m, 29 July 1992, Yamashita s.n. (Tochigi Pref. Museum). Nikko, Mt. Nantai-san, 2 August 1921, Ogura s.n. (TI); 7 July 1924, leg. ign. s.n. (TNS); July 1929 & 3 July 1931, leg. ign. s.n. (TNS); 3 July 1931, Hara s.n. (TI); 4 August 1931, Shimada s.n. (TNS); 2 July 1934, Ito s.n. (TI); 10 September 1934, Koidzumi 94467 (TNS); 5 July 1964, Shibusa s.n. (Tochigi Pref. Museum); 2,300 m, 15 June 1982, Ogura s.n. (Tochigi Pref. Museum); 2,200 m, 22 June 1982, Ogura s.n. (Tochigi Pref. Museum); 2,240 m, 24 July 1983, Ogura & Noguchi s.n. (Tochigi Pref. Museum); 2,300 m, 9 August 1997, Hasegawa s.n. (Tochigi Pref. Museum); 2,240 m, 15 October 2002, Suzuki s.n. (Tochigi Pref. Museum). Nikko, Mt. Nantai-san, Hanatate-sawa, 27 June 1997, Shibata s.n. (Herb. Dept. Biol., Nippon Dental Univ.). Nikko, Mt. Nantai-san, above Shizu-goya Shelter, 4 June 2001, Shibata s.n. (Herb. Dept. Biol., Nippon Dental Univ.). Nikko, Mt. Nyoho-san, June 1901, Matsumura s.n. (TNS); 4 July 1903, Takeda s.n. (MAK, TI); July 1905, Sakurai s.n. (TNS); 2 September 1905, Hayakawa s.n. (TI); 10 August 1908, Sakurai s.n. (E); July 1913, Koidzumi s.n. (TI); 6 August 1914, leg. ign. 140 (KYO); 20 June 1916, Kurihara s.n. (GMNHJ); 28 May 1924, Kishida s.n. (TNS); 26 July 1924, Narita 1376 (A, BM, PE, TI); July 1924, Hayakawa 8 310 (TI); July 1924, Hayakawa T609 (TI); 2 July 1933, Ito s.n. (TI); 2 July 1933, Tsuyama s.n. (TI); 1,900 m, 24 July 1951, Furuse 23871 (PE); 6 July 1952, Kubota s.n. (Tochigi Pref. Museum); 2,000 m, 6 July 1952, Okuyama 16772 (TNS); 1,800 m, 7 July 1952, Yamazaki 3122 (TI); 2 June 1961, Shibusa s.n. (Tochigi Pref. Museum); 5 July 1965, Okuyama & Okuyama 24712 (TNS); 2,090 m, 26 September 1984, Ogura s.n. (Tochigi Pref. Museum). Nikko, S of Mt. Nyoho-san, 1,850 m, cultivated material vouchered on 15 July 2001 (originally collected at the habitat on 12 October 1999 by Steiger), Steiger s.n. (JE). Nikko, Mt. Nyoho-san, Karasawa, s.d., Zyoo s.n. (TI). Nikko, Mt. Nyoho-san, above Nanataki, 20 June 1891, Zyoo s.n. (TI). Nikko, Unryu-keikoku Gorge, 1,500 m, 30 July 1972, Nakayama s.n. (Tochigi Pref. Museum); 23 June 1981, Sato s.n. (Tochigi Pref. Museum); 1,450 m, 3 June 1983, Ogura & Noguchi s.n. (Tochigi Pref. Museum); 1,500 m, 14 August 1996, Hasegawa s.n. (Tochigi Pref. Museum); 29 June 1999, Hasegawa s.n. (Tochigi Pref. Museum); 1,250 m, 13 July 2005, Ogura s.n. (Tochigi Pref. Museum). Nikko, locality not specified, June 1901, leg. ign. s.n. (MAK); August 1908, Yokohama

Nursery Co., LTD. s.n. (E). Misc. (Prefecture not specified): Mt. Kesamaru-yama, 2 July 1978, Sudo s.n. (GMNHJ). (Locality not specified): July 1910, Mochizuki s.n. (E).

[Note] Old local names have been revised. All specimens at Department of Biology, Nippon Dental University were transferred to TNS in 2013.

Acknowledgements: The author is indebted to Drs. Anthony Brach (A; Harvard University), Jonathan Gregson (BM; Natural History Museum), Lesley Scott (E; Royal Botanic Garden Edinburgh), Takehiro Ohmori (GMNHJ; Gunma Museum of Natural History), Joern Hentschel (JE; Friedrich Schiller University Jena), David J. Goyder (K; Royal Botanic Gardens, Kew), Hiroaki Setoguchi (KYO; Kyoto University), Roman Ufimov (LE; Russian Academy of Sciences), Noriaki Murakami (MAK; Tokyo Metropolitan University), Zhi-Rong Yang (PE; Chinese Academy of Sciences), Hideki Takahashi (SAPS; Hokkaido University Museum), Tetsuo Toma (TI; University of Tokyo), Atsushi Ebihara (TNS; National Museum of Nature and Science), Sadashi Komiya and Chiaki Shibata (Nippon Dental University), and Naoto Hoshi (Tochigi Prefectural Museum) for their curatorial assistances, Eri Tobe (Waseda Junior & Senior High School) for mineral identifications, and Asako Tsuda (Ministry of the Environment) and Satoru Honma (Agency for Cultural Affairs) for informative comments concerning the current legal statuses. Similarly, the author would like to express his sincere thanks to Mr. Takayuki Uzawa and Ms. Kaori Ichikawa (Hitachi High-Technologies Corporation) for their technical support using Miniscope® TM3030Plus, and to Dr. Amy Hinsley (University of Kent) for linguistic corrections and critical reading of the manuscript.

References

- Beck, S., Fleischmann, A., Huaylla, H., Müller, K.F., and Borsch, T. 2008. *Pinguicula chuquisacensis* (Lentibulariaceae), a new species from the Bolivian Andes, and first insights on phylogenetic relationships among South American *Pinguicula*. *Willdenowia* 38: 201-212.
- Casper, S.J. 1962a. On *Pinguicula macroceras* Link in North America. *Rhodora* 64: 212-221.
- Casper, S.J. 1962b. Revision der Gattung *Pinguicula* in Eurasien. *Feddes Repertorium* 66:1-148.
- Casper, S.J. 1963. Gedanken zur Gliederung der Gattung *Pinguicula* L. *Botanisch Jahrbücher* 82(3): 321-335.
- Casper, S.J. 1966. Monographie der Gattung *Pinguicula* L. *Bibliotheca Botanica* 127/128.
- Casper, S.J., and Stimpert, R. 2009. Chromosome numbers in *Pinguicula* (Lentibulariaceae): survey, atlas, and taxonomic conclusions. *Plant Systematics and Evolution* 277: 21-60.
- Cieslak, T., Polepalli, J.S., White, A., Müller, K., Borsch, T., Barthlott, W., Steiger, J., Marchant, A., and Legendre, L. 2005. Phylogenetic analysis of *Pinguicula* (Lentibulariaceae): chloroplast DNA sequences and morphology support several geographically distinct radiations. *American Journal of Botany* 92(10): 1723-1736.
- Ernst, A. 1961. Revision der Gattung *Pinguicula*. *Botanisch Jahrbücher* 80(2): 145-194.
- Gloßner, F. 1992. Ultraviolet pattern in the traps and flowers of some carnivorous plants. *Botanisch Jahrbücher* 113(4): 577-587.
- Heslop-Harrison, J. 1970. Scanning electron microscopy of fresh leaves of *Pinguicula*. *Science* 167: 172-174.
- Heslop-Harrison, J. 2004. *Pinguicula* L. *Journal of Ecology* 92: 1071-1118.
- Juniper, B.E., Robins, R.J., and Joel, D.M. 1989. *The Carnivorous Plants*. Academic Press, London.
- Kano, K. 1965. Studies on the media for orchid seed germination. *Memoirs of Faculty of Agriculture, Kagawa University* 20: 1-68.

- Karlsson, P.S. 1986. Seasonal pattern of biomass allocation in flowering and nonflowering specimens of three *Pinguicula* species. Canadian Journal of Botany 64: 2872-2877.
- Komiya, S. 1972. Systematic studies on the Lentibulariaceae. Dissertation, Nippon Dental College, Tokyo.
- Komiya, S., and Shibata, C. 1980. Distribution of the Lentibulariaceae in Japan. Bulletin of Nippon Dental University, General Education 9: 163-212.
- Komiya, S., and Shibata, C. 1998. A comparative-study of *Pinguicula ramosa* Miyoshi and *P. variegata* Turcz.; Ecology and morphology. Second conference of the International Carnivorous Plant Society, Botanischer Garten Bonn, Germany, Proceedings, Schlauer, J., and Meyers-Rice, B. (ed.), p. 23.
- Komiya, S., and Shibata, C. 1999. Japanese *Pinguicula* (Lentibulariaceae). [in Japanese]. Bulletin of the Nippon Dental University, General Education 28: 117-146.
- Kondo, K., and Shimai, H. 2006. Phylogenetic analysis of the northern *Pinguicula* (Lentibulariaceae) based on transcribed spacer (ITS) sequence. Acta Phytotaxonomica et Geobotanica 57(2): 155-164.
- Löve, A., and Löve, D. 1982. IOPB chromosome number reports LXXV. Taxon 31(2): 342-368.
- Miyoshi, M. 1890. Notes on *Pinguicula ramosa* sp. nov. Botanical Magazine Tokyo 4: 314-319.
- Oba, H., Shimizu, J., Ayabe, M., and Tateno, M. 2013. Winter bud induction and optimal seed storage conditions of *Pinguicula ramosa* Miyoshi (Lentibulariaceae). [in Japanese with English abstract]. Bulletin of Japan Association of Botanical Gardens 47: 84-90.
- Shimai, H., and Kondo, K. 2007. Phylogenetic analysis of Mexican and Central American *Pinguicula* (Lentibulariaceae) based on internal transcribed spacer (ITS) sequence. Chromosome Botany 2: 67-77.
- Tamura, M. 1953. Key to the insectivorous plants of Japan. Acta Phytotaxonomica et Geobotanica 15(1): 31-32.
- von Arx, B., Schlauer, J., and Groves, M. 2001. CITES Carnivorous Plants Checklist. Royal Botanic Gardens, Kew.
- Yoshimura, K. 1973. Studies on the chromosome number and karyotype of *Pinguicula ramosa* Miyoshi (Lentibulariaceae). Journal of Japanese Botany 48(10): 289-294.
- Zhukova, P.G., and Tikhonova, A.D. 1971. Chromosome numbers of certain plant species indigenous to the Chukotskiy Province. Bot. Zhurn. 56: 868-875.

HIRO SHIMAI

Born in Higashi-Hiroshima, Hiroshima, Japan. Botanical curator. Postgraduate research works at the University of Nottingham (in horticulture) and the University of Kent (in conservation). The author has extensive field observations of *Pinguicula* at habitats in Europe, Turkey, Cyprus, North and South Americas, Cuba, and Japan as well as specimen examinations at herbaria. Currently, the author is reviewing geographical distribution patterns of *Pinguicula* taxa based on specimens. Other interests are tropical plants, wetland plants, and plant conservations at botanical gardens.



Hiro Shimai searching for *Pinguicula crystallina* in Mugla Province, Turkey.

GETTING TO MT. KOSHIN-ZAN

The closest train station to Mt. Koshin-zan is Haramuko Station on the Watarase Keikoku Railway line, connecting Kiryu and Mato stations along the upper half of the Watarase-gawa River (Fig. 1). To access from Tokyo, Tobu Railway's the "Ryomo" limited express train (seat reservation required) departs hourly from Asakusa Station in central Tokyo to Aioi Station, a transfer station

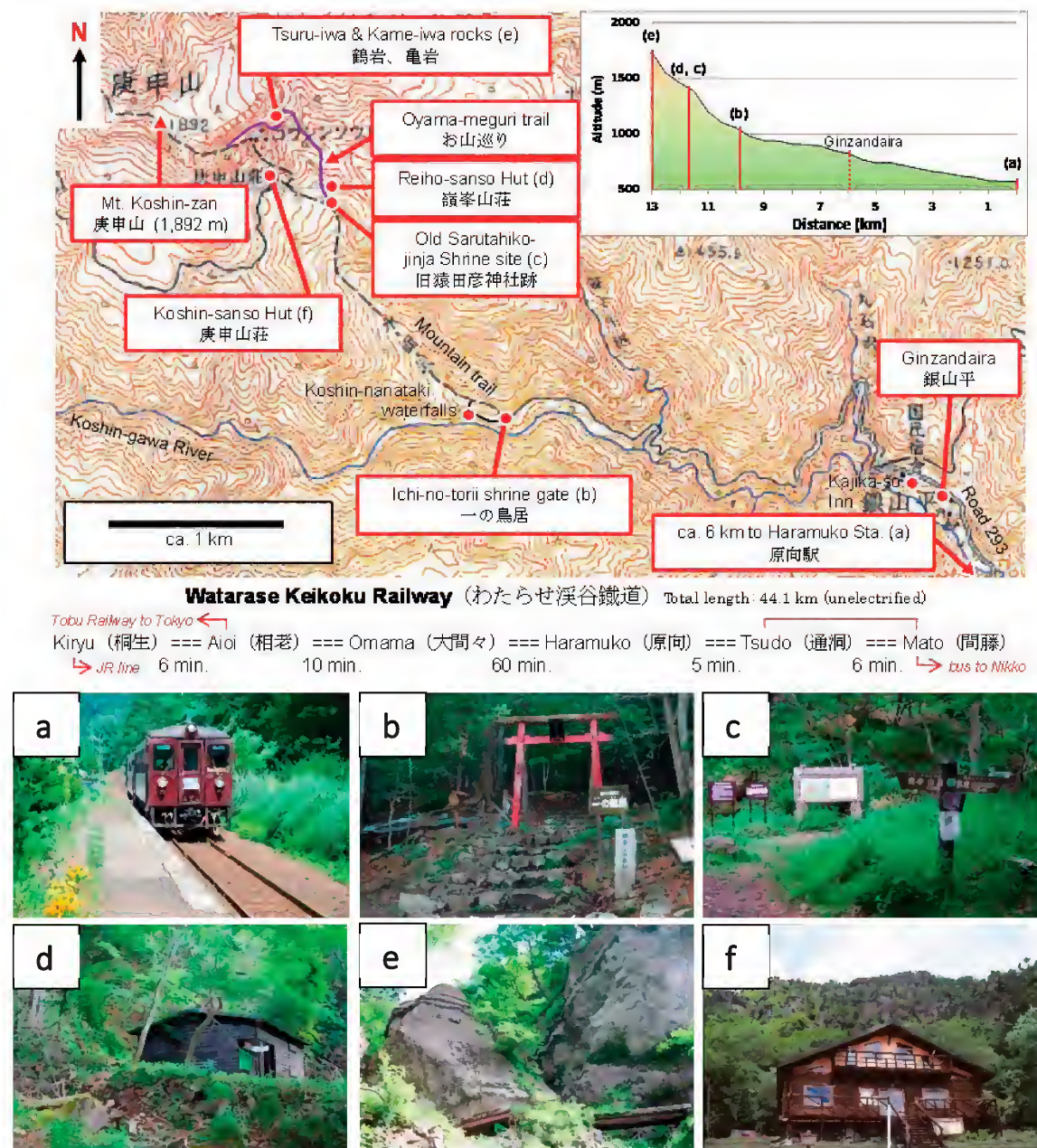


Figure 1: Map around Mt. Koshin-zan and views. The map was reproduced from 1:50,000 topographic maps "Ashio (NJ-54-30-9)" and "Nantai-san (NJ-54-29-12)" issued by Geospatial Information Authority of Japan. a) Haramuko Station, b) Ichino-torii shrine gate, c) Old Sarutahiko-jinja Shrine site, d) Reiho-sanso Hut, e) *P. ramosa* habitat of Kame-iwa rock (right) and Tsurigane-iwa rock (left). Tsuru-iwa rock, not shown in the picture, is located just on the left hand side of Tsurigane-iwa rock, f) Koshin-sanso Hut.

to the Watarase Keikoku Railway line, taking ca. 1 h 45 min. Then it takes further ca. 70 min. from Aioi Station to Haramuko Station.

The distance from Haramuko Station to Ginzandaira, a trailhead area, is ca. 6 km following on Road 293. There are no public transportations to reach Ginzandaira, but a taxi is available at Tsudo Station, or a mini-bus service may be arranged by Kajika-so Inn in Ginzandaira if staying there at least one night with an advanced booking. Then the road, mostly unpaved, continues approximately 4 km from Ginzandaira (ca. 840 m alt.) to Ichi-no-torii shrine gate (ca. 1,050 m alt.) along a deep gorge of the Koshin-gawa River, but no vehicles are permitted to enter beyond Kajika-so Inn (gate closed).

From Ichi-no-torii shrine gate, where an actual mountain trail starts, it will take approximately 1 h 20 min. for ca. 2 km to reach Old Sarutahiko-jinja Shrine site (the shrine buildings were destroyed by fire in 1946). A branch trail to Koshin-nanataki waterfalls diverging on the left from the main trail at ca. 150 m above Ichi-no-torii shrine gate is not for the mountain. The mountain trail runs mostly in a forest but signs and artificial objects indicate the route. At Old Sarutahiko-jinja Shrine site (ca. 1,450 m alt.), the trail diverges into two directions, the left trail goes for Koshin-sanso Hut or the summit of Mt. Koshin-zan, and the right trail goes a counterclockwise direction of Oyama-meguri trail. It will take further a few hours for a complete trekking on Oyama-meguri trail (ca. 2.5 km long). Tsuru-iwa and Kame-iwa rocks, almost the middle way on the loop trail, are good places to observe *P. ramosa*. To reach those rocks, the zigzagged steep trail, a counterclockwise direction on the loop, goes up from Old Sarutahiko-jinja Shrine site through behind Reiho-sanso Hut (not open to public). There are ladders and chains to climb up rocks or steep slopes on some parts of the trail. Immediately after passing beneath the overhanging rock of Kame-iwa, the *P. ramosa* habitats are just there.

Koshin-sanso Hut, ca. 200 m above Old Sarutahiko-jinja Shrine site, has basically no manager except weekends during peak seasons and only very basic facilities just for sleeping are provided. A number of people visit the mountain to see *P. ramosa* during the flowering season in June and it tends to be congested in the hut on weekends, but no reservations are accepted.

Alternatively, there is a local bus service between Nikko Stations and Tsudo Station (no rail link between those) taking about 50 min. though only 6 times per day. Nikko is a very popular holiday destination so that two different railway operators, JR and Tobu, connect Tokyo and Nikko. Car rental is also available in Nikko.

Because of higher elevations, the habitat is not easy to reach. The flowering season in the first half of June is usually about the beginning of rainy season. Appropriate shoes for trekking, a water-proofed jacket, large-scale maps (1:50,000 or 1:25,000), food and water, and very careful planning are required. There could be a higher risk of heavy rain particularly in the afternoon on the mountain. Under poor weather conditions, it is very dangerous to get there.

C

Z

P

WWW.CZPLANTS.COM

carnivorous & exotic plants



WATER PROPAGATION OF THE VENUS FLYTRAP

BRYN JONES • PO Box 244 • Yinnar • Victoria 3869 • Australia • bryn@shutyourtrap.com.au

In the past I have taken a leaf pulling of my flytrap and planted it in a 50:50 mix of peat moss and washed sand (as I would grow any of my flytraps) in the hope that it would then produce another plant. Unfortunately though I found this method to be not the most successful as I could succeed less than half of the time. Earlier this year I stumbled across water propagation and decided to give it a go.

This is possibly the most successful propagation method that I have tried on my Venus flytraps. Using this method I was able to have a success rate of almost 100% for all the leaf pullings that I took.

The basic process is just taking the leaf pulling and then placing it into a container of water under a grow light for a month or so. I will describe the entire process I used with some photos. You can give it a go yourself.

I started this little experiment at the start of April 2015 and I potted the rooted pullings in June and July 2015.

Step 1: Getting the leaf pulling

Taking the leaf pulling is best done when repotting your flytrap. When I have upended my pot I will shake loose the excess soil and then place the entire plant into a bucket of water and let it soak. I shake the plant gently so that there is no soil remaining on the plant. You will then be able to divide the plant into however many plants have divided from it naturally. I place all of the smaller divisions into a bowl of water and leave them until ready to be potted. This can wait a day if you aren't quite ready.

I then grab the largest healthiest looking plant, find the big healthy leaves, and then pull them gently downward towards the rhizome (The leaves that are easiest to get are the ones that are growing from the outside of the rhizome). The leaf will break off at the base of the plant and you will see there is a bit of white rhizome on the base of the leaf. Keep doing this until you have removed the accessible healthy leaves from your plant, while leaving the main part of the plant with many leaves.

Note: Don't forget to repot the original plant (Fig. 1).



Figure 1: *Dionaea* 'B52' growth after 2 months.



Figure 2: Pulled leaves before trimming.

Step 2: Preparing the leaf pullings

Put all the leaves from each different plant into their own separate jar (Fig. 2) and rinse them in lukewarm water a few times to remove all of the soil that was on them. Once you have all the leaves of one plant together, take each leaf and cut off the trap at the end of the leaf.

Step 3: Add water and light

Once you have cut off all the traps (and thrown them away) place all of the trimmed leaves into their jar/container (I used a 250 mL jam jar), fill it with demineralized water and place a lid on it (Fig. 3). Then all you need to do is simply place the jar underneath some lights. I treat the jar as if it were a pot of seeds that I want to germinate so I place it under some lights with a photoperiod of around 12-14 hours.

Step 4: The magic!

I found that after 1 month of not touching the jars, nearly all of the leaves had started to produce roots and leaves from the base of the leaf (Fig. 4). Some had also sprouted roots from the point of where the trap was cut off.

Step 5: Removal and planting

Once all the leaves had produced roots and leaves (I found that this took between 2-3 months) I removed the leaves from the jar of water (Fig. 5). You will notice that the original leaf will have started to die back from the top. To some of the leaf pullings before potting, I cut off the dead part of the leaf only really to make it look nicer.

Then all you need to do is plant your newly formed plants into your standard soil mix (some of my pots I used a 50:50 mix of sand and perlite and to others I used 100% peat moss, in this instance it hasn't seemed to have made a big difference) and place into a cheap \$10 mini greenhouse so that you can keep the plants in a humid environment to acclimatize. Over the next 2 weeks or so open the vents slowly until you remove the lid altogether (Fig. 6).

I still actually have my little plants growing inside under lights as I haven't made the time to move them outside with my other plants. They have been planted for 2-3 months now and seem to be going strong.

If you are going to take leaf pullings, I would strongly recommend using this method.

Happy Growing!



Figure 3: Trimmed leaves in jars.



Figure 4: Trimmed leaves after a month.



Figure 5: Rooted leaves after 2-3 months.



Figure 6: *Dionaea* "Dutch Delight" freshly planted and 1-2 months later.



Ferocious Foliage.com
Custom Tissue Culture Laboratory

Terrific alternative to a hanging basket.
 Pots are 10" in diameter, 7 ¼" tall
 with a ~1.75 gallon capacity.
 Terraces are 14 ½" tall.

info@ferociousfoliage.com

\$5.00 each + S/H

Ferocious Foliage
 P.O. Box 458
 Dahlonega, GA 30533



Plant not included

PROPAGATING *DROSOPHYLLUM* FROM CUTTINGS

MARK S. ANDERSON • Vancouver • Washington • USA

Some years back I saw a short article in the 1988 Carnivorous Plant Newsletter where Richard Tilbrooke described how he had taken some of the plantlets that are often formed on the old flower stalks of *Drosophyllum lusitanicum* and rooted them into new plants (see Carniv. Pl. Newslett. 17(4): 106-107.) However, it seems no one I have heard from was ever able to reproduce that feat. Generally the plantlets slowly died when cut from the mother plant and placed in moist growing medium. Still, when looking at a stem just loaded with the little devils (Fig. 1) it seemed like there must be a way. While I was considering this, it happened that I had made up a standard-strength batch of gibberellic acid (GA3 – 1000 ppm) solution to treat seeds in an attempt to rouse them from a deep dormancy. Since the already-mixed solution was just sitting, I took 3 plantlet cuttings and stood them in the shallow container, cut-end submerged, for one hour each. I then planted them into my standard *Drosophyllum* medium giving them more water than adult plants usually like.

For several weeks I watched the plantlet cuttings and waited for the eventual wilting and death of the little green sprigs. But that's not what happened. In fact, I became convinced that they were putting out new growth and getting larger. So I decided to sacrifice one just to see what was really going on (Fig. 2). Since *Drosophyllum* hate having their roots disturbed, I “knew” that the plant was very likely to die, but I repotted it anyway. It continued to grow and eventually produced flowers of its own. Of 3 cuttings taken for propagation, all 3 survived and became independent plants. I believe that anyone who has successfully grown *Drosophyllum* can reproduce these results.



Figure 1: Plantlets growing on the old flower stalk of the parent plant.

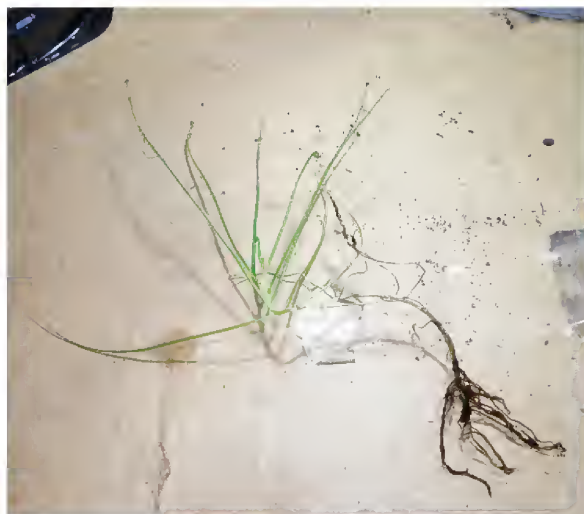


Figure 2: A cut *Drosophyllum* plantlet several weeks after planting showing the new roots (left) and detail of new roots with the old cut sites outlined in red (right).

NEW CULTIVARS

Keywords: cultivar, *Cephalotus follicularis* 'Bananito', *Drosera* 'Anemone', *Drosera burmannii* 'Pilliga Red', *Drosera* 'Scarlet Tears', *Nepenthes* 'Autumn Wine', *Sarracenia* 'Ares'

Sarracenia 'Ares'

Submitted: 18 February 2016

Sarracenia 'Ares' is a lost label cultivar from the early years of my breeding efforts. Over the past twenty years it has proven to be vigorous and dependable — my first really good red *Sarracenia* hybrid (Fig. 1 & Back Cover). The pitchers erupt over a short period early in the growing season and are generously produced. The near uniform red color, for me, is deeper in warmer and brighter weather. The color holds until senescence and may even deepen with age. The pitchers are erect through the growing season. The rhizomes branch regularly making a plant that fills a pot nicely.

For me here in Washington state *Sarracenia* 'Ares' plants typically grow 50 to 60 cm tall pitchers and produce hoods that reach 9 to 13 cm across. The plant's flower starts out pink towards the center and grades to a creamy white suffused with pink towards the ends (Fig. 1).

Ares is named for the god of war and his bloody work is echoed in the cultivar's ruddy coloration.

To maintain these memorable characteristics, this plant should be reproduced only by vegetative means.

—JERRY ADDINGTON • Courting Frogs Nursery • Stanwood • Washington • USA • jerry@courtingfrogs.com



Figure 1: *Sarracenia* 'Ares' pitchers (left) and flower (right).

Submitted: 24 December 2015

This plant was produced in late 2014 by crossing a specimen of *Drosera* sp. Lantau Island (thought to be a fertile hybrid of *Drosera oblongeolata* × *spatulata*) with *D. capensis* 'Albino', resulting in a stout rosetted plant bearing semi-erect elongate leaves intermediate between the paddle-shaped leaves of the mother and the strap leaves of the father, and was the only seed to successfully sprout. The plant can reach, possibly exceed, 76 mm across, and leaves up to 5 mm off the ground. Even in full sun the leaves retain a greenish to slightly yellowish ground color, blushing on the edges and in the tentacles with scarlet (Fig. 3). Flower stalks can be incredibly tall, upwards of 46 cm or more with blooms 2 cm wide and a delicate pale pink shade (Fig. 2).

The name originates from the appearance of the outstretched leaves, extending in all directions greedily like the stinging tentacles of sea anemones, and adorned with attractive bright colors to match. This is a sterile hybrid, capable of being propagated only by vegetative means such as leaf or root cuttings.

—HAWKEN CARLTON • 4627 Mesa Verde Dr. • Greeley • Colorado 80634 • USA • hawken.carlton5@gmail.com



Figure 2: *Drosera* 'Anemone' flower.

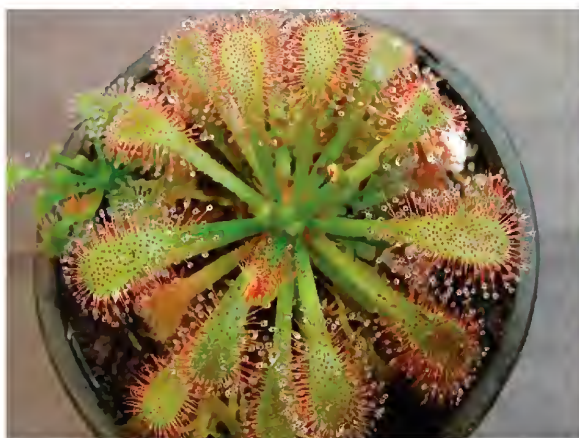


Figure 3: *Drosera* 'Anemone' top and side views.

Drosera ‘Scarlet Tears’

Submitted: 3 January 2016

Drosera ‘Scarlet Tears’ (Fig. 4) is a beautiful plant with a complex background. In early 2015, a specimen of *Drosera anglica* from the Alakai Swamp locality of Hawaii was crossed with a horticulturally made *D. spatulata* hybrid between the cultivar *D.* ‘Tamlin’ and a pink-flowered locality plant from Royal National Park in Sydney, Australia. This breeding produced a batch of seedlings that are fully subtropical in nature and relatively large, with variable specimens bearing both pink and white flowers and ranging from relatively green to bright red leaves.

From this batch, a single pink-flowered specimen was selected for its larger size and rich color. The rosette can reach up to 8 cm across, the semi-erect leaves stretching upward as they first grow out to a height of 3 cm before falling toward the soil. When the leaves first unfurl they are a rich olive green with scarlet tentacles, infusing rapidly with color to become fully scarlet or burgundy. The short flower stalks to 16 cm will bear small, 1 cm pink blooms.

The name, coined by my sister Holly, reflects the aged red color and the appearance of the leaves, the lamina on the tip of the narrow petiole is like a rounded tear that rolls down one’s face, stretching itself and leaving a thin stain behind as it travels.

As this is a sterile hybrid and a unique clone among dozens of siblings, this cultivar is suitable only for vegetative reproduction. Scape/peduncle, leaf, and root cuttings will all strike quickly.

—HAWKEN CARLTON • 4627 Mesa Verde Dr. • Greeley • Colorado 80634 • USA • hawken.carlton5@gmail.com



Figure 4: *Drosera* ‘Scarlet Tears’ top and side views, portraying the semi-erect rosette nature and reddened hue of the plant.

Nepenthes ‘Autumn Wine’

Submitted: 24 December 2015

Received as a seed-grown plant from Tony Paroubek in late 2013, this plant has proven to be a vigorous grower and tolerant of a wide range of temperatures. It is a result of the cross *Nepenthes* “Viking” (*mirabilis* var. *globosa*) #19 × (*maxima* × *trusmadiensis*) and displays much of the shape of the female parent along with coloration and pitcher details of the male.

Leaves can exceed 40 cm long, semi-oblong with a tapering tip, a very slightly peltate tendril attachment on most and with a slight tendency to blush red under strong light. Upper pitchers can reach over



Figure 5: Upper pitcher of *Nepenthes* 'Autumn Wine' showing the faint hourglass shape and wide peristome.

18 cm long and unlike lowers have only a pair of ridges in place of the wings. They are roughly infundibular with a very slight bulge approximately halfway down the pitcher, giving the profile a faint hourglass shape like a fancy wine goblet (Fig. 5). Upper pitchers typically have a larger, flared peristome compared to lowers, and while in lower pitchers the peristome may wrap around the lip of the pitcher it will often stay open and nearly flat in uppers. The lower pitchers can reach over 13 cm tall and up to 8 cm wide, roughly cylindrical in shape throughout with a slight bulge below the mouth and bearing distinct rigid wings (Fig. 6). The peristome is wide, with small but distinct ridges and the smallest of teeth along the inside edge, and the lid is roughly ovular and bears numerous obvious nectar glands on the underside. Both lowers and uppers may be covered in a very thin indumentum, visible in bright light on the sides of the pitcher and tendrils.

This plant is named after its notable coloration, the body of the pitchers infused from opening with a rich maroon red like that of an expensive red wine that deepens with age, lower pitchers sometimes reaching a state of almost black cherry coloration. Faint, darker blotches are also present like stains of wine on an old tablecloth. The peristome is heavily striped in varying shades of yellow, orange and red, like the colors of autumn leaves, infusing as it ages with the same wine-red coloration of the pitcher body, the stripes staying evident as they darken in turn.

Having yet to flower, the sex of this plant is unknown. To maintain the special characteristics of this cultivar it can only

be propagated by vegetative means such as cuttings of the stem or basal shoots.

—HAWKEN CARLTON • 4627 Mesa Verde Dr. • Greeley • Colorado 80634 • USA • hawken.carlton5@gmail.com



Figure 6: Typical lower pitcher of *Nepenthes* 'Autumn Wine', showing the deep wine coloration and faint "stain" blotches on the pitcher body as well as the thin indumentum (left) and peristome detail (right). Distinct ridges and heavy striping are present on all pitchers, stripes staying visible even in dark, aged peristomes.

Cephalotus follicularis ‘Bananito’

Submitted: 11 April 2016

In 2012, I received four plants produced from seeds of *Cephalotus* ‘Eden Black’ selfed. In general, *Cephalotus follicularis* plants are very similar to each other, but one of these plants produced an unmistakable elongated shape, like a banana (Fig. 7). On 3 April 2014, I named this plant *Cephalotus follicularis* ‘Bananito’. The name “Bananito” is Italian for “small banana”.

This plant is very vigorous. The pitchers have maintained their characteristic shape while being grown both indoor and outside. To preserve the unique characteristic of the cultivar, reproduction should be by vegetative means only.

—ERIO PIACENTI • 40129 Bologna • Italy • eriomix@alice.it



Figure 7: *Cephalotus follicularis* ‘Bananito’ with the characteristic elongated banana-like shape.

Drosera burmannii ‘Pilliga Red’

Submitted: 28 March 2016

In the late 1990s when I lived in Dubbo in inland New South Wales I found several populations of *Drosera burmannii* Vahl. in the local region. Most of the local plants comprised plants with green to red rosettes, but they all had white-petalled flowers. However, two of those populations contained plants that developed red-leaved rosettes and had flowers with pink-petals (Fig. 8). Plants grown



Figure 8: Red rosettes of *Drosera burmannii* 'Pilliga Red' south of Narrabri and in scape. Note the pink petals on the recently-closed flower.

from seed from the northern population also developed red leaves and had pink flowers. They began to enter cultivation under the informal name of “Pilliga Red” – a name suggested during correspondence with Ivan Snyder. I propose to formally name such plants as *Drosera burmannii* 'Pilliga Red'.

This cultivar is named after the Pilliga State Forest in inland north eastern NSW, Australia. The largest population of these heavily pigmented plants occur in this state forest on the southern shore of an ephemeral lake about 37 km south of Narrabri. The second population I found is 12 km north-east of Dubbo. This cultivar name applies to plants with the same pigmentation pattern from those populations and other populations elsewhere in the region. As with other plants of *D. burmannii*, flowers of *D. burmannii* 'Pilliga Red' open only for a few hours in the morning.

—ROBERT GIBSON • 5 Kristen Close • Cardiff Heights • NSW 2285 • Australia • robert.gibson@environment.nsw.gov.au

Cascade Carnivores

Carnivorous Plant Nursery

Mexican *Pinguicula*
- Butterworts are our specialty!

Utricularia
- Terrestrial and epiphytic

Nepenthes
- Highland species/cultivars

***Drosera*, *Dionaea*, *Drosophyllum* and more...**

Website - www.cascadecarnivores.com
Email - support@cascadecarnivores.com
Phone - 425.336.1420

CALIFORNIA CARNIVORES

The Largest Most Famous CP Nursery in North America

Home of the largest collection of CP in the world on display Thurs. - Mon. 10 Am - 4 Pm

We ship only the highest quality plants in our deluxe pots to the entire U.S.

Owned by Peter D'Amato, author of "The Savage Garden"

707-824-0433

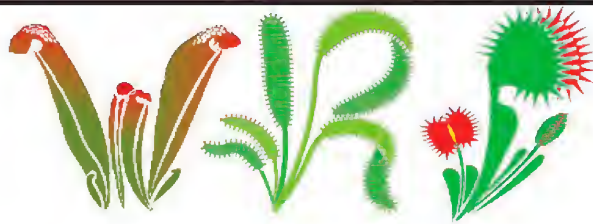
www.CaliforniaCarnivores.com

info@californiacarnivores.com



Best Carnivorous PLANTS STORE

www.BestCarnivorousPlants.net



World's Rare Plants

Largest Carnivorous Plant Store in San Francisco Bay Area

<http://www.worldsrareplants.com>

Sarracenias • Sundews • Nepenthes • Venus Fly Traps • Terrariums • CP Soil Mixes

Also featuring Fairy Garden Supplies

12511 San Mateo Rd (Highway 92), Half Moon Bay, Ca 94019

Walk-ins welcome

or call 650-454-9002

